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ABSTRACT

Presented are 11 papers given at a conference on the evaluation of sensory aids for the visually handicapped which emphasized mobility and reading aids beginning to be tested and distributed widely. Many of the presentations are by the principal developers or advocates of the aids. Introductory readings compare the role of evaluation in the prosthetics and orthotics program to the area of sensory aids and review the history of braille. Reading machines are considered in five papers with the following titles: "Evaluation of Certain Reading Aids for the Blind", "Experience in Evaluation of the Visotoner", "Optacon Evaluation Considerations", "Plans for the Evaluation of a High Performance Reading Machine for the Blind", and "A Digital Spelled-Speech Reading Machine for the Blind". The evaluation of mobility aids is examined in five papers with the following titles: "The VA--Bionic Laser Cane for the Blind", "Experience in Evaluation of the Russell Pathsounder", "Evaluation of the Ultrasonic Binaural Sensory Aid for the Blind", "Dearing Light Sensing Typhlocane--Model LST-3, and "Evaluation of Mobility Aids". Extensive appendixes include the conference agenda, a list of participants, an evaluation of binaural sensory aid for the blind, the instruction manual for the Dearing Light-Sensing Typhlocane, and discussions about personal reading appliances for the blind, factors retarding sensory aids research for the blind, and the evaluation of the Kay Binaural Sensor. (DB)

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EVALUATION OF
SENSORY AIDS
FOR THE
VISUALLY HANDICAPPED

NATIONAL ACADEMY OF SCIENCES

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ED 081156

EVALUATION OF
SENSORY AIDS
FOR THE
VISUALLY
HANDICAPPED

A report on a conference sponsored by the

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COMMITTEE ON PROSTHETICS RESEARCH
AND DEVELOPMENT
of the
DIVISION OF ENGINEERING
NATIONAL RESEARCH COUNCIL

held at the
NATIONAL ACADEMY OF SCIENCES
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November 11-12, 1971

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PREFACE

In convening this Conference on Evaluation of Sensory Aids for the Visually Handicapped, the Subcommittee on Sensory Aids confined the scope to mobility and reading aids. It set the following objectives, with emphasis on the first two:

- Secure presentation describing aids that are near decision points affecting relatively widespread testing and potential distribution
- Secure presentation by "advocates" of aids, where a "prime" advocate is the inventor, developer, or sponsor
- Expose several potential governmental funding agencies to the presentations
- Encourage a "confrontation" between advocates and the agencies to clarify the nature of the evaluative data to be garnered by the one side and weighted by the other

The first two of the objectives appear to have been well met, for, as the papers in this report demonstrate, a number of the presentations are by prime advocates of the currently most promising aids. The second pair of objectives was but partially achieved for a variety of reasons.

The speakers were given the guidelines reproduced in Appendix J, the guidelines emphasize the concrete. The written papers satisfy the guidelines fairly well, and some can serve as fact-laden histories of the development of aids.

Strategies of significant evaluation remain to be worked out. Members and friends of the subcommittee have suggested, for example, that a permanent laboratory devoted to evaluation be set up, and that formalized evaluative procedures and criteria would be most helpful to funding agencies. As part of the aftermath of the conference, the subcommittee has engaged a statistical consultant, Dr. Innis Sande, who is examining past and current evaluative methods, and who is endeavoring to learn from the funding agencies what forms of evaluative data can be most efficiently and powerfully processed.

--Newman Guttman

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THE ROLE OF EVALUATION IN THE PROSTHETICS AND ORTHOTICS PROGRAM

Colin A. McLaurin

As a result of a request from The Surgeon General of the Army, the National Academy of Sciences established in 1945 a research program in artificial limbs. This program in 26 years has grown to become a relatively large integrated program involving research, development, evaluation, and education in limb prosthetics and orthotics.

At the beginning of the Prosthetics and Orthotics Program, it was generally believed that the major problems could be solved by the design of improved hardware, which, of course, could be done rapidly by applying the marvelous new technology that had produced the remarkable machines of war. However, it was not long before the need for fundamental research was recognized, and shortly afterwards came the realization that the coupling of the man and the machine was of utmost importance.

In spite of some false starts and the discovery of some blind alleys, devices and techniques began to emerge from the laboratories, and then it soon became evident that the developing groups were in no position to evaluate effectively their own products. Many of the reasons for this seem obvious.

In an attempt to accelerate progress, and to develop experience and a body of knowledge for teaching, a formal evaluation program was organized. An evaluation group, which had no other responsibility, was established within a university and charged with determination of the relative worth of new devices and techniques as they were developed. Although the evaluation program has been modified over the years as experience has been gained, it has been recognized by all who have been involved as being a most necessary link in the chain between fundamental research and widespread clinical application.

The main result in evaluating any device or technique is an independent assessment of the value in terms of function, cost, durability, comfort, or appearance. The assessment is often made in comparison with a similar device or technique. The result is seldom a simple yes or no conclusion, but more often a sequence of recommendations for modification or redesign. Thus evaluation becomes integrated in the development program--with the developing laboratory and later the manufacturer making whatever improvements are indicated.

The evaluation program as it progresses from laboratory fittings to field testing also serves to introduce the device or technique to other centres and teaching institutions. The experience gained with a variety of patient types and needs usually concludes with indications for prescription. It is seldom that any new device has universal appeal but rather may have advantages for certain individuals and uses. The process also includes the suitability of any instruction manuals and the "teachability" of techniques. Thus evaluation is not a simple testing procedure; it becomes a complex, closely integrated part of the overall process in effectively developing a product until it is ready for routine use.

It appears that the Sensory Aids Program has reached the stage where hardware is becoming available, and it seems that, based on our experience in limb prosthetics and orthotics, consideration should be given to the establishment of a comparable evaluation program.

BRAILLE: A SUCCESS STORY

Warren Bledsoe

The U.S. Veterans Administration's chief expert on blindness, Russell C. Williams, is fond of quoting Sir Winston Churchill's remark to the faculty of MIT, "I never had any formal scientific education; I just picked up a little bit here and a little bit there." To this I believe Churchill added, "Once after dinner all higher methematics passed before my eyes, but it was after dinner and I let it go."

To me it is a source of wonder and joy that I should be speaking at the National Academy of Sciences, inasmuch as I never got any scientific training at all. However, as a mere student in the English Department at Princeton in the 1930s, I was taught to respect hard-core science. (Soft sciences had not yet been invented.) I was also taught some respect for mere facts and logic, as well as historical method. So it is with these simple tools that I will attempt to lay bare the significance of the manner in which braille took hold in the lives of blind people, first in France and then all over the world.

Before doing so I would like to set forth my own test of the success of inventions. The most important consideration with respect to any invention is that it WORK: work in the sense of performing (if it is a pump, pump; if it is a light, light) and work in the sense of serving the purpose for which it was designed (pump enough water for the family or town, and put enough light in the lighthouse to warn a ship off a reef). I believe that where inventions for the blind are concerned we have had so little regard for the first consideration that we have had great trouble with the second. Dr. Richard E. Hoover, who changed our whole system of training newly blinded people, has said many times that he believes a key factor in getting his long-cane technique accepted was the availability of 300 highly durable, 6-oz. canes of thin-walled steel, which had been available toward the end of the war by a factory that had been given an A-1 priority by the Surgeon General of the Army.

After Thomas B. Sheridan of MIT had been made acquainted with the problems of blindness and attempts to solve them, through the excellent tutoring of John Dupress (at whose name I personally feel like bowing), Sheridan said, "Inventing for blind people seems rather on a par with inventing a needle than inventing a steam engine, and of course much harder." Along this line I have sometimes thought that that great friend of the blind, Charles Ritter, put as much in the hands of blind people by shopping at hardware and novelty stores as grave men have done by administration.

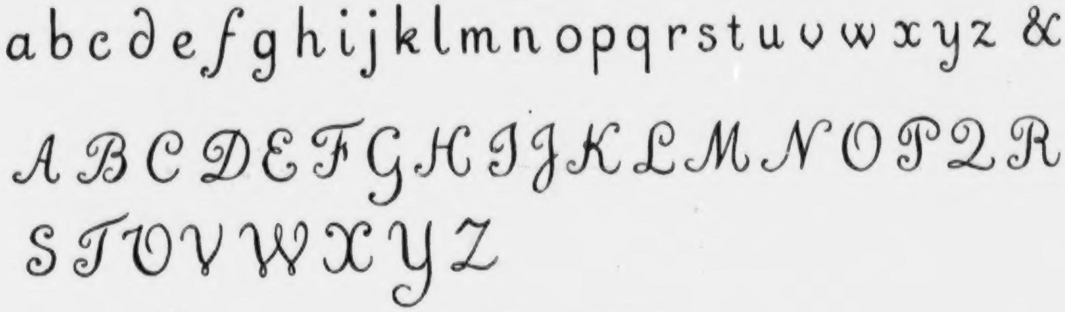
In turning our attention to braille I would like to go back to one of the classic documents in our field, Denis Diderot's letter (afterwards his essay) on blindness, based very largely on an interview in great depth with one blind individual. In this he brought forth a reaction which had great significance when he quoted the blind individual as saying he would rather have endlessly long arms than eyesight. This is an extreme appreciation of touch, but the thought is expressed often enough by blind individuals to be significant. The success of braille is to be measured in its peculiar suitability for perception by an extension of the mind in the fingertips, which blind people frequently develop. They of course do not receive it automatically as a gift of God, as that excellent psychologist, Dr. Samuel Hayes, proved over and over again.

My function today is to tell you a little about the way in which six little dots won their way in the welter of good intentions, ambition, good will, and vanity which washed around efforts to help blind people years ago, even as it does now.

Some embossed alphabets which have been developed for blind people are shown in Figure 1 and a replica of a string alphabet once devised and used by some sturdy Scotch people is shown in Figure 2.

The first type is that which was devised at the first school for the blind in the world, the Paris school founded by the "Father of the Blind," Valentin Hauy. This type set in motion the concept that embossed type for the blind should resemble, insofar as possible, ordinary print. It has been suggested that this would make it easier for the instructor to follow

TYPES FOR THE BLIND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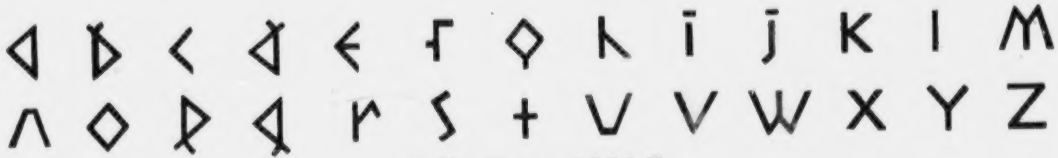
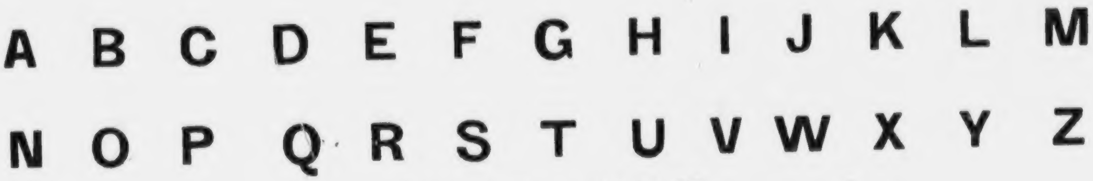
Hauy's Type, 1786.



Gall's Type, 1826-7.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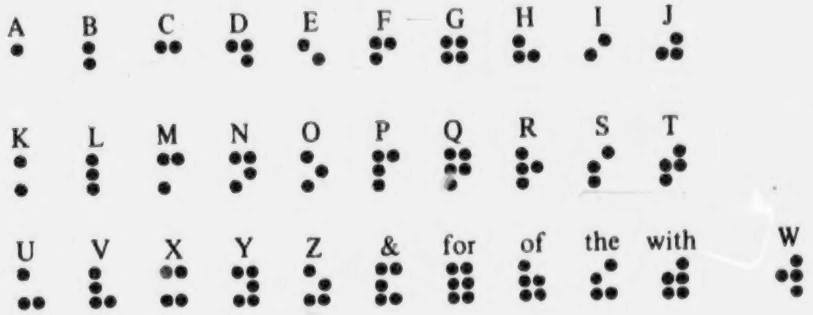
Alston's Type, 1829-37.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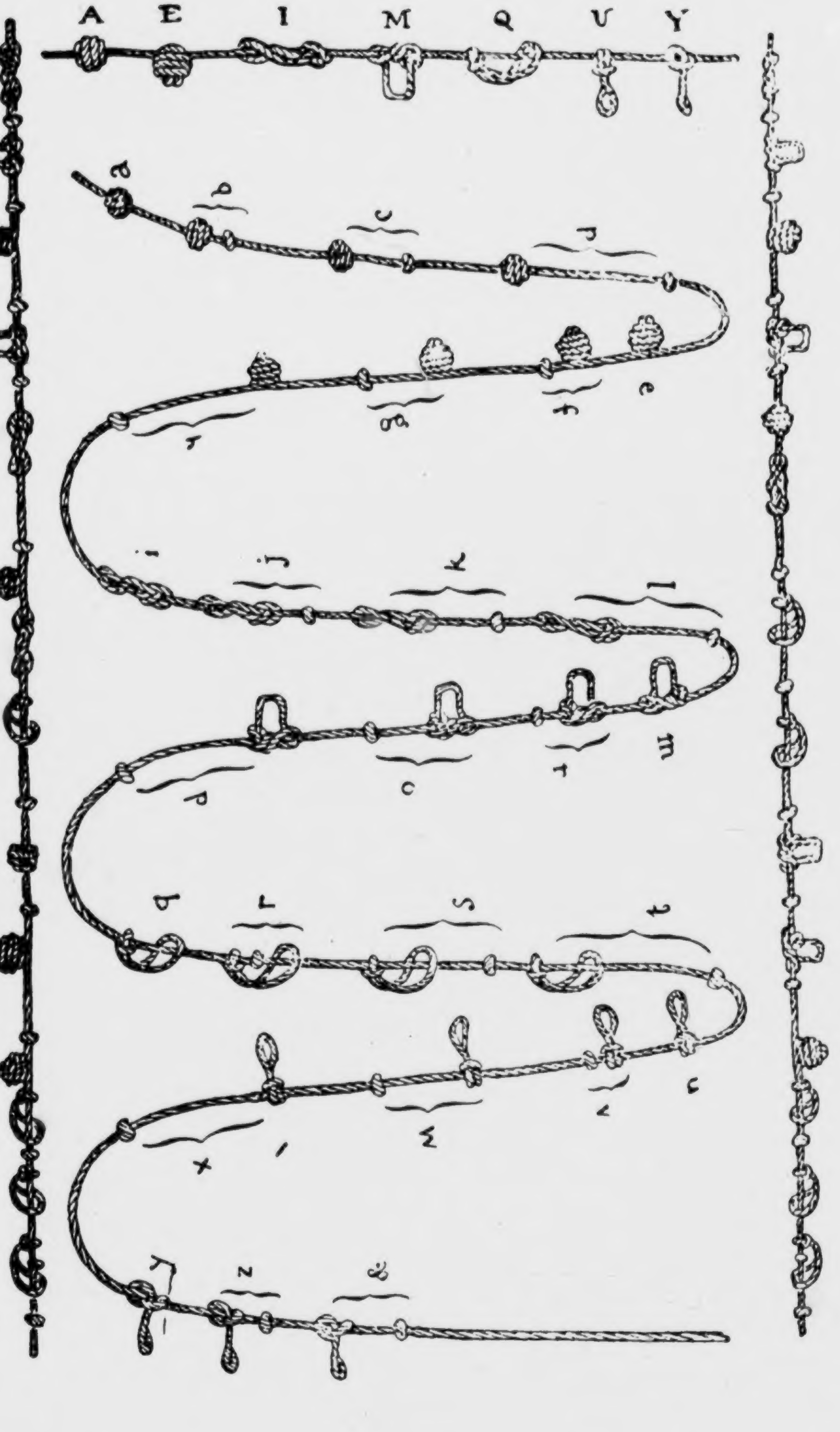
Braille Type, 1927.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Specimens of String Writing.

the text of the blind pupil. This doesn't seem very sensible since printed duplicates of the text are more readily available than embossed type.

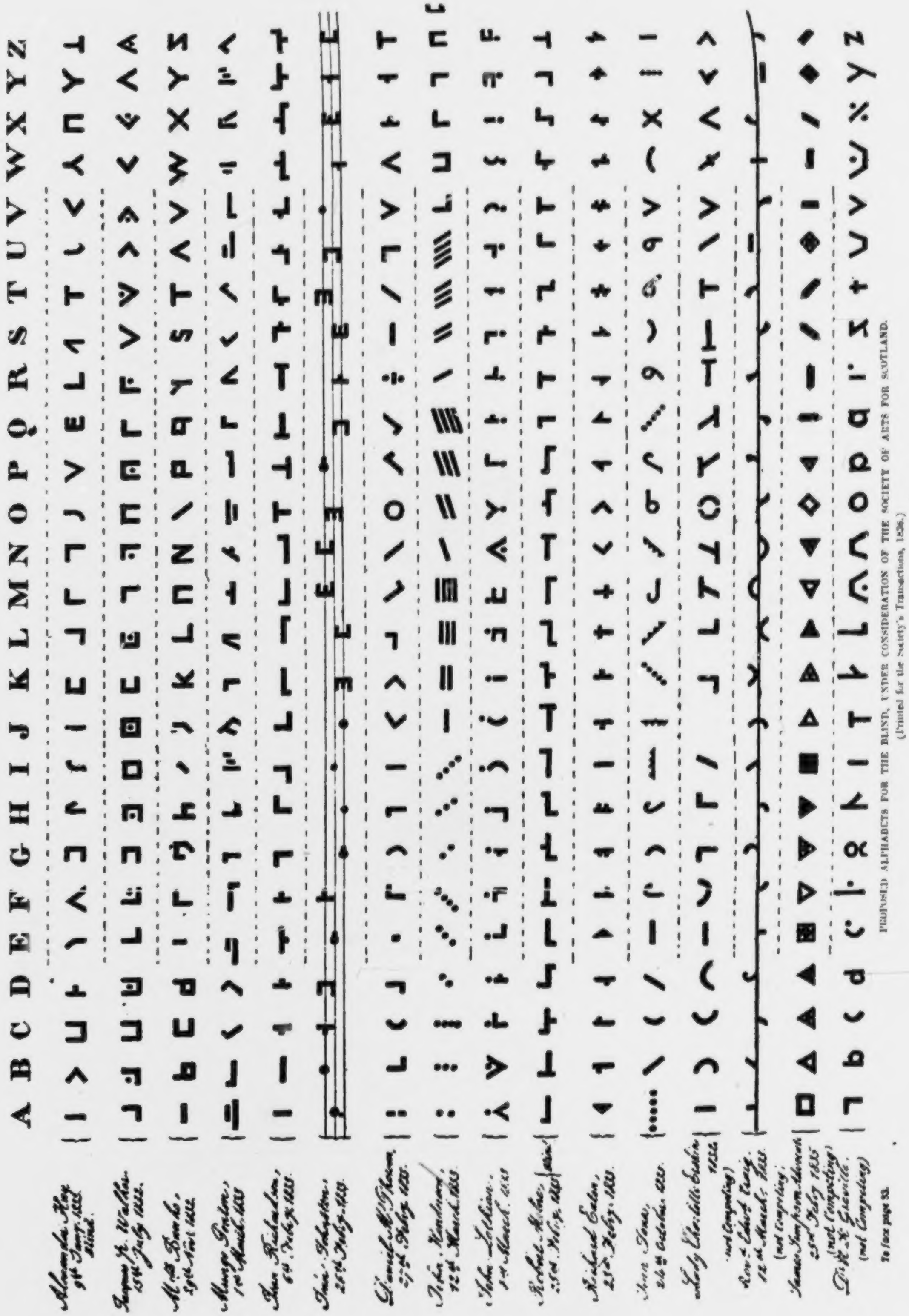
Something far more subtle explains this adherence to raised letters, and something far more important because it is the nub of an ancient conflict between two classic principles which cross and contend with each other in work for the blind. The first is a rule of common sense; the second a rule of high seriousness. The rule of common sense calls for use of the remaining senses not necessarily as sighted people use them, or in a way which gives the appearance of a sighted person. The high principle calls for integration with the sighted world at all costs. Even great people such as Samuel Gridley Howe and Wilhelm Klein at times put a very great premium on performing in the ways of sighted people. In its extreme form this demands doing things the way one would if he were sighted even when that way is very much less efficient. An example of this is Howe's insistence, to his dying day (1876), on the use of raised letters rather than dots. Braille had then been in existence for 50 years. This is a shunning to excess of anything that makes a blind person seem atypical, and not by a hidebound pedagogue, but an individual of breath-taking venturesomeness who stretched the minds of others to the breaking point.

Thus the first and most significant competition which braille had to face was not other systems of dots, but the entrenchment of the Roman alphabet for so long a time after a dot system was available. The reason for reviewing this time-worn subject is that, in our own time, now and then persons of importance in the scientific field grab the concept of raised letters out of the thin air and do an end-run with it behind their own goal line. This causes dismay to old hands in the field of work for the blind because we went all through this principle with our famous professional great-great-grandfather, who was too august for anyone to gainsay him for 50 years and who prevented several generations of blind children from reading by the method which is most suitable.

Very soon after introduction of formal education programs for the blind (Fig. 1) experiments were begun with other than Roman alphabets that were designed to be touched and not to be seen. Sixteen of these (Fig. 3) were under consideration by the Society of Arts for Scotland in 1836.

One of the most satisfactory accounts of Louis Braille, and the evolution of braille, is given by Sir Clutha Mackenzie[1], who quotes Mr. Pierre Henri, a blind music teacher in the Paris School for the Blind. In 1950 Mr. Henri occupied the same position which Braille had occupied in the 1820s, and made it his business to set in order the facts attending the conception and birth of the system. Henri described Braille as an extremely intelligent, young, blind music teacher, 16 years old in 1825, and tells how he grew interested in a raised dot phonetic code, developed by an artillery officer, Capt. Charles Barbier, for sending messages which could be read at night. Success depended upon the decoder's ability to keep in mind an imaginary parallelogram of 36 squares, each square relating to a speech sound. He would receive a message in two columns of raised dots, the number of dots in the first column indicating the vertical position, the second column indicating the horizontal position of the square in the parallelogram in which a sound was located. Thus painfully and phonetically, if sender and receiver were sufficiently keen, and sufficiently fortunate, a message could be transmitted. The code was not an alphabet; it was not braille. But it used raised dots. Correspondence between Barbier and Braille shows Louis Braille crediting Barbier with having given him the idea of using dots and Barbier crediting Braille with having put it to an entirely different, ingenious and practical use, as well as inventing a slate on which it could be handwritten.

Pierre Henri offers this keen observation: "It has been said that the reason who Louis Braille's system has proved superior to all other forms of writing for the blind is that it bore the stamp of genius. To put matters more simply, it results from a combination of skill with patient and methodical labour. Braille was blind, and only a blind man could have arranged dots in groups which exactly correspond to the requirements of the


A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

PROPOSED ALPHABETS FOR THE BLIND, UNDER CONSIDERATION OF THE SOCIETY OF ARTS FOR SCOTLAND.

(Printed for the Society's Transactions, 1836.)

To face page 53.

Figure 3.

sense of touch. Reduce the number of dots and the available signs become obviously insufficient; add to their number, and the signs can no longer be covered by the fingertip, nor so easily read."

We can sketch only briefly the puzzlements of how braille won its way through anfractuous courses to worldwide acceptance. Some of the difficulties have been exaggerated. Some could not possibly be exaggerated.

Legend has sometimes claimed that braille was suppressed and ignored in the Paris School. Henri claims that it was not. It was when it crossed the channel and later the Atlantic that the trouble started. Its basic principle, the use of dots, made headway in Britain, but with a different grouping which was to be known as English braille. Later, in America, further variations were put forth in a system called American braille, and even more radical variations in the system known as New York Point.

A religious war which was waged off and on for three quarters of a century broke out over which system should be used. It ended officially in 1933 when an international conference adopted uniform type.

The war itself offers an important and revealing study of the dynamics of human efforts to help blind people, including efforts of the blind to help themselves and extricate themselves from the webs which emotion seems to weave about them. No one authority should be relied on by the student of this war. There are a number of gospels to be consulted: Robert Irwin's "War of the Dots" in his memoirs "As I Saw It"; Dr. Richard French's "The Point System and Later Phases of Embossed Literature"; "The Battle of the Types" in Gabriel Farrell's "The Story of Blindness." A synoptic gospel is Dr. Berthold Lowenfeld's opening chapter in "Blind Children Learn to Read." One of the most poignant discourses is by the rather valiant (and perhaps most scientific) educator in the fray, William Wait of New York, the inventor of the New York Point System, who was a sort of General Lee in the War of the Dots, a loser whom many people thought the best educator of the blind of his time. As principal of the New York Institute for the Education of the Blind, he published the argument for his system in the 1908 Annual Report of the school under the title "Key to the New York Point System of Tangible Writing and Printing," as follows:

A brief reference to the origination, development and general adoption of the New York Point System of tangible literature and Music will be fitting in this place.

Immediately after taking charge of the New York Institution in 1863, I made an effort to establish the course of instruction upon a text-book basis, and in this way to enlarge the opportunities of the pupils for reading and study, and to lessen their almost total dependence upon their teachers, who, because of the lack of suitably embossed text-books, were obliged to impart instruction in all branches almost wholly by the oral method.

As a first step, a test of the reading power of each pupil was made, which disclosed that a majority of the pupils were unable to read at all, while only a few could read well.

The system then accepted and in general use was the Boston Line, a form of the ordinary Roman type, and as the only books then available were in that style, an intensive effort was made to impart to every pupil the power of facile finger reading.

This special effort, covering two years, proved that a large proportion of the pupils, including many having excellent mental endowments, were wholly unable to read the Boston Line books, and from data furnished by other schools, confirmed by my own observations, it was clear that similar inability to read existed in all the schools.

But, besides the lack of tangible power, the Roman form was found deficient in two other vital points: it is tangibly unwritable, and cannot be adapted to musical notation.

The conclusion inevitably was that the Roman or Line letters do not possess the three qualities--tangibility, writability and adaptability--essential in a system of embossed literature, and that the problem could be solved only by the adoption of embossed points in both writing and printing.

There was in use in this school at that time, and for some years prior, a point alphabet on a vertical base of six points, arranged by one of the teachers, Mr. Adam McClelland, himself blind, and possessing rare intellectual gifts.

It is a matter of interest that Prof. Louis B. Carll while a pupil learned the system, and afterward used it in writing his great work, "Calculus of Variations." . . .

It was with this alphabet that my first tests of the comparative tangible power of points and lines were made with pupils who could not read the latter, and which demonstrated the superiority of point signs over line signs.

But while Mr. McClelland's alphabet could be written as easily and appealed to the touch as strongly as any of the vertical systems, it was not adaptable to the structure of a musical notation, and this caused me to take up the original vertical point system of M. Louis Braille.

My examination of the structure and application of this system developed the fact that it is defective in several important respects: it is much more bulky and hence more costly than the Boston Line (which in the absence of any other system was then taken as a standard, and the cost of which was almost prohibitive); the number of possible single signs, sixty-three, is inadequate to the requirements of Literature, of Mathematics and of Music, so that none of these subjects can be correctly and fully represented by them.

From anything that could be learned from other sources about the Braille system, the existence of these inherent and grave defects had not been suspected, and when as the result of this inquiry they were disclosed, but one course was left open, which was to devise some different method of sign building, by which the structural defects of the Braille might be avoided, the number of signs greatly increased, and the cost of books reduced to the lowest possible minimum. Obviously, two things only could be done: employ two points instead of three points vertically, and a series of base forms developing horizontally, and holding two, four, six, eight, ten, etc., points each.

With infinite care and labor I put this idea into effect, the final outcome being the New York Point System.

All the facts and data acquired throughout the years of study and laborious experiment that seemed to have no end can be found in full in the yearly reports of this Institution. In the reports for 1866 and 1867 the subject of embossed alphabets and books was generally considered. In the report for 1868 the New York Point Alphabet is given. In this connection it is proper to state that no details of the system were published until after I had stated to Dr. S. G. Howe, of the Boston School, and to Mr. William Chapin, of the Philadelphia School, that I had constructed a system demonstrably superior to that of M. Braille, but that in the interest of uniformity I would abandon any further effort on a new line if they would join me in adopting, improving and establishing the Braille system. My proposal was not received with favor, and I was therefore under no obligations either to adopt or advocate the defective Braille system as against a demonstrably better one, and the New York System was published.

In 1871, at the Indianapolis meeting of the American Association of Instructors of the Blind, the New York and Braille Codes were critically examined and compared, after which the Convention voted without a dissenting voice that the New York System ought to be taught in all schools for the blind.

In 1872, at the Boston meeting, I presented an outline of a system of Musical Notation complementary to the literary system, and was requested by the Convention to complete the system in detail, so that the schools might have the use of it as soon as possible.

The first edition of the Notation was printed in our report for 1872.

In 1878 the Music Notation was considered at length, and again approved by the Association.

Down to 1882 the entire United States Fund had been used in printing Boston Line books, but in that year 50 per cent of the fund was set apart for books in New York Point.

In 1892 it was decided by the American Association of Instructors of the Blind that only reprints of Line books should be issued, and that any part of the 50 per cent that had been reserved for Line books, not so needed, should be used in printing books in New York Point.

At the same time, 1892, twenty-four years after the New York Code had been published and twenty-one years after it had been accepted by the American Association and commended for general adoption, and after the Association had six times confirmed the New York System and six times refused to recognize any form of Braille, either original or derived, French, English or American, a small minority of the principals, in defiance of these repeated sanctions of the New York System and disavowals of all varieties of Braille by the Association, and willfully disregarding the great importance of having only one point system, needlessly and harmfully thrust forward a schismatic form of the Braille code, which they named American Braille.

In 1894, at a meeting of the trustees of the American Printing House for the Blind, and as a climax of a two years' campaign of propaganda, a motion was made to change the by-laws so as to recognize and promote American Braille. Twenty-six institutions were represented, and after full consideration five voted for and twenty-one voted against such recognition.

The facilities for writing and printing the New York Point System consist of a desk tablet, a pocket tablet and two machines: the Kleidograph for paper writing, and the Stereograph for embossing metal plates for use in printing.

The tablets have been improved by substituting a rectangular groove in place of a V-shaped groove or of separate pits.

Patents were granted for the Kleidograph and the Stereograph, which were at once transferred to the New York Institution without pecuniary advantage to myself.

. . . .

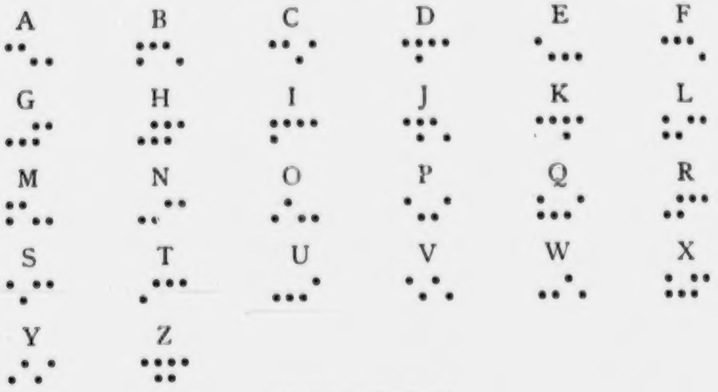
This laborious and perplexing work has not been done solely from personal preference on my part, but primarily as a matter of duty, and to improve the methods and enlarge the means of education here and elsewhere.

It has ever been to me a source of satisfaction and encouragement that the Managers of this Institution have warmly sustained me throughout and have furnished every needed facility for putting the fruits of my efforts into permanent practice.

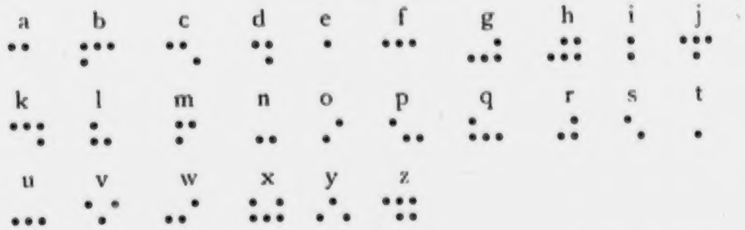
NEW YORK POINT

THE ALPHABET.

CAPITAL LETTERS.



SMALL LETTERS.



It will be observed that the capital letters are derived from the small letters, by suffixing to each of them as many points as will form a new character four points in length, in the following manner:

First. When the small letter ends with a point in the upper row, as in the letter a, add the suffix in the lower row.

Second. When the small letter ends with a point in the lower row, as in c, or in both upper and lower rows, as in d, add the suffix in the upper row.

With the Kleidograph and Stereograph the small letters can be made into capitals by means of stylets which form larger points than those in the small letters.

NUMERALS.

1	2	3	4	5	6	7	8	9	0
⠛	⠉	⠚	⠋	⠙	⠓	⠊	⠑	⠃	⠁

Prefix, indicating that the characters which follow are numerals, ⠛⠃ Thus, 1908, ⠛⠃|⠛|⠃|⠁|⠑. The vertical line indicates a blank space equal to one point.

PUNCTUATION MARKS.

Period, ⠛ , preceded and followed by a blank space equal to two points

Comma, ⠁ , preceded and followed by a blank space equal to two points.

Semi-colon, ⠂ , preceded and followed by a blank space equal to two points.

Colon	⠓	Acute Accent	⠛⠊
Apostrophe	⠋⠙	Grave Accent	⠛⠒
Hyphen	⠋⠋	Circumflex	⠛⠚
Exclamation	⠚	Diæresis	⠛⠑
Interrogation	⠙	Cedilla (French)	⠒⠁
Parenthesis *	⠋	Tilda (Spanish)	⠒⠁
Asterisk	⠒⠓	Italics	⠛⠛
Quotation *	⠓⠂	Italics ended	⠛⠛|⠃||
Dash	⠒⠒		

* Placed before and after the word or words affected by the sign.

ADAPTATIONS FOR GREEK.

Coronis	⠉⠂	Ps	⠑⠁
Long e	⠉⠁	Iota subscript	⠚⠂
Long o	⠙⠁	Rough breathing	⠚⠃

The accents are placed before accented letters and syllables, and are separated from them by one blank.

SIGNS OF ABBREVIATION.

First class: Abbreviation by initial capital letters. Any proper name may be represented by its initial letter. The same letter may stand for different proper names in different books, or in different parts of the same book, but they should not be used in such a way as to obscure the meaning.

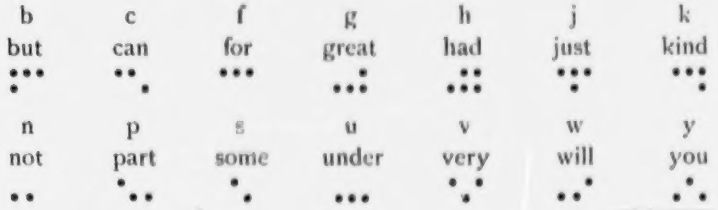
In each case, the word to be abbreviated should be written in full when it first occurs.

When desirable, a full list of abbreviated words should accompany the book, with a partial list at the head of each chapter.

When an initial capital stands for a word, a word space should precede and follow it.

Second class: Abbreviations by small letters, to be used only as separate words.

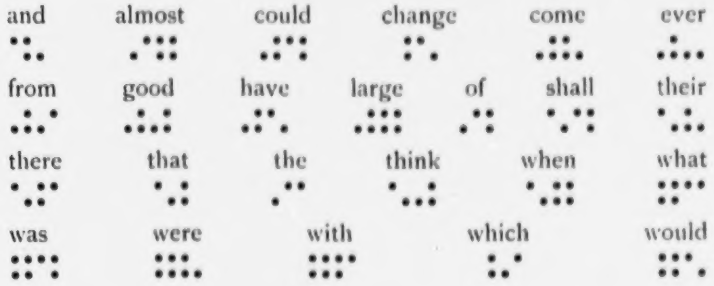
ABBREVIATIONS BY SMALL LETTERS.



b	c	f	g	h	j	k
but	can	for	great	had	just	kind

n	p	s	u	v	w	y
not	part	some	under	very	will	you

ABBREVIATIONS FOR WORDS AND PARTS OF WORDS BY SIGNS OTHER THAN CAPITAL OR SMALL LETTERS.



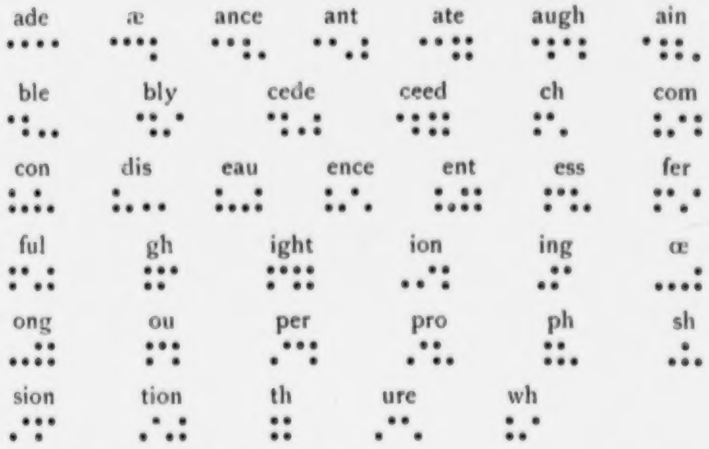
and	almost	could	change	come	ever	
from	good	have	large	of	shall	their
there	that	the	think	when	what	
was	were	with	which	would		

These signs may stand for separate words, or may form parts of words.

In using a contraction to form part of a word, syllabication and pronunciation should be strictly observed.

Thus: Mo*th*er, not Mo*ther*; Finger, not F*ing*er; Andante, not *And*ante.

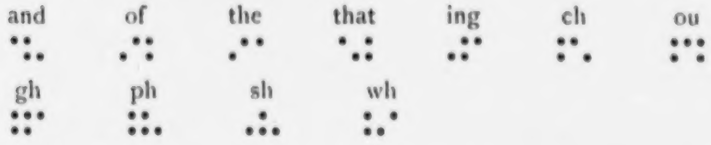
SIGNS FOR SYLLABLES, DIPHTHONGS, TRIPHTHONGS, DIGRAPHS, ETC.


ade
æ
ance
ant
ate
augh
ain
ble
bly
cede
ceed
ch
com
con
dis
eau
ence
ent
ess
fer
ful
gh
ight
ion
ing
œ
ong
ou
per
pro
ph
sh
sion
tion
th
ure
wh

It will be helpful for the student to arrange the contractions in reference to their base forms.

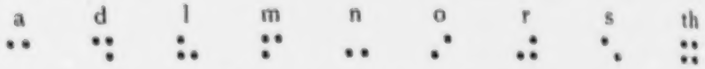
The Second base has but one contraction, viz: th ⠛

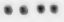
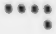
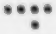
The Third base has 11 contractions, viz:

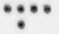
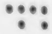
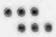

and
of
the
that
ing
ch
ou
gh
ph
sh
wh

The Fourth base has 81 signs divided into nine groups of nine signs each.

The signs in each group of nine may be considered as made up of the signs formed on the Second base by a regular mode of compounding. Thus the signs of the Second base are:


a
d
l
m
n
o
r
s
th

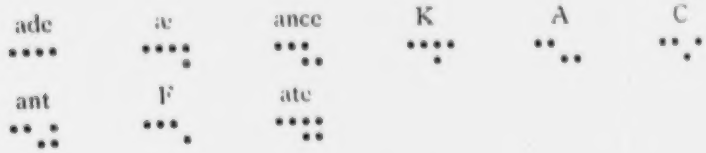
Beginning with the first one, a new series may be formed by adding to it each one in order thus:    etc.

Beginning with the second one, we have    etc.

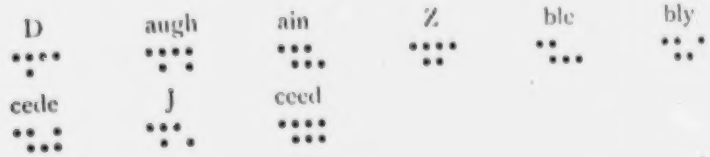
In this way the nine groups are formed. These signs represent 26 capitals, 9 punctuations and 47 contractions, one sign of the ninth group having a double use. The entire series in nine groups can be readily acquired on the principle of association.

The following are the signs of the Fourth base, arranged in nine groups:

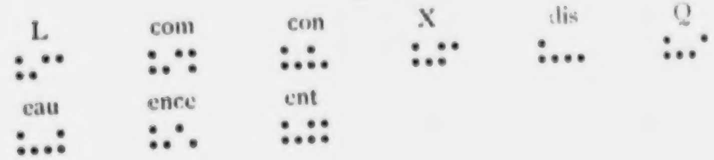
FIRST GROUP.


ade
æ
ance
K
A
C
ant
F
ate

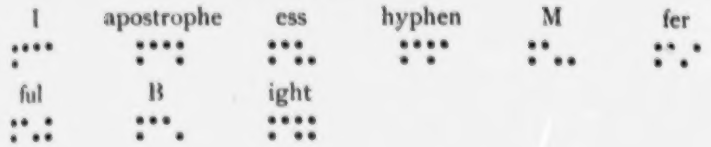
SECOND GROUP.


D
augh
ain
Z
ble
bly
cede
J
ceed

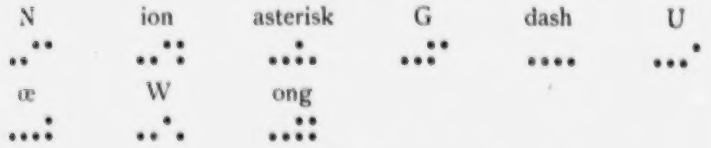
THIRD GROUP.


L
com
con
X
dis
Q
cau
ence
ent

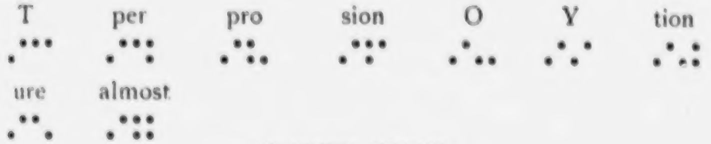
FOURTH GROUP.


I
apostrophe
ess
hyphen
M
fer
ful
B
ight

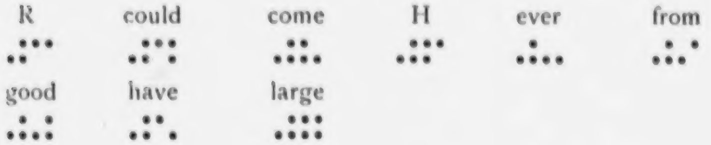
FIFTH GROUP.


N
ion
asterisk
G
dash
U
œ
W
ong

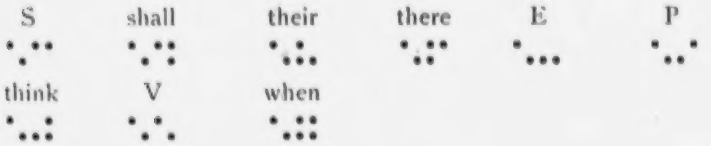
SIXTH GROUP.


T
per
pro
sion
O
Y
tion
ure
almost

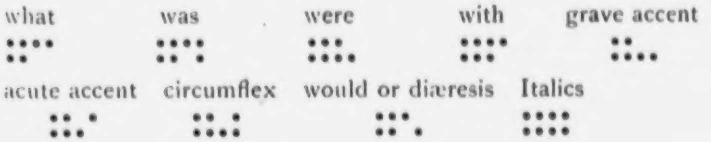
SEVENTH GROUP.


R
could
come
H
ever
from
good
have
large

EIGHTH GROUP.

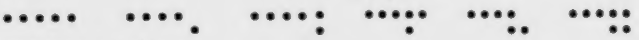

S
shall
their
there
E
P
think
V
when

NINTH GROUP.


what
was
were
with
grave accent
acute accent
circumflex
would or diæresis
Italics

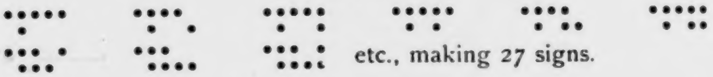
The Fifth base has 243 signs derived by suffixing to each of the 81 signs of the Fourth base the three signs respectively of the first base, viz: ˙, . and :. Thus:

FIRST GROUP.



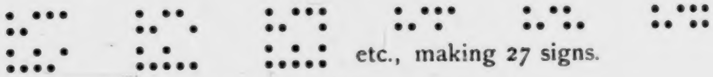
etc., making 27 signs.

SECOND GROUP.



etc., making 27 signs.

THIRD GROUP.

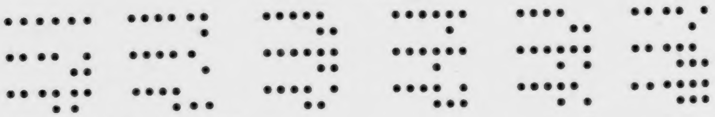


etc., making 27 signs.

The remaining six groups follow the same form.

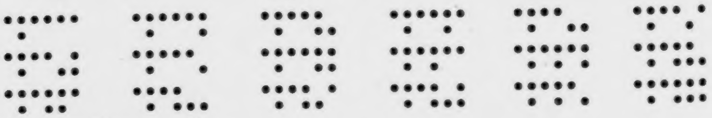
The Sixth base has 729 signs derived by suffixing to each of the 81 signs of the Fourth base the 9 signs respectively of the Second base. Thus:

FIRST GROUP.



etc., making 81 signs.

SECOND GROUP.



etc., making 81 signs.

The remaining seven groups are similarly formed.

The use of the signs of the Fifth and Sixth bases lies in an extension of the important field of contraction for both writing and printing, without the further development of which no economy in the bulk and cost of books can be hoped for beyond that already secured by the present practice of the New York Point System.

Larger bases than the Sixth are used for special purposes.

This report reads as though Wait thought the battle had been won. Such was not the case. Yet the threat to his system lay not where he thought it did, but in so-called British braille which almost seems to have lain in wait during the decades while the exponents of the two American systems contested with each other both technically and politically. A study of the intricacies of the contest in the United States is worth the time of responsible problem solvers in the field of American work for the blind. Reading and re-reading of the gospels on the subject give a fair grasp of what happened. But the most important lesson to be learned is in the role played by British practicality and British diplomacy.

Consider what French says about British braille:

> Braille was introduced into Britain about 1868, but it was fully twenty years before it had anything like general recognition in institutions for the blind. According to Illingworth, "In Scotland especially it was bitterly opposed by the home-teaching societies, and even at the Edinburgh institution, it was only after years of persuasive entreaty that the then manager, William Martin, succeeded in getting the teachers at West Craigmillar to give 'Braille' a trial." The greatest single step in advance in Britain was the formation, in 1868, of the British and Foreign Blind Association for Promoting the Education and Employment of the Blind, of which Dr. Thomas Rhodes Armitage was the leading spirit for many years. While the purposes of the association included all matters concerning the education and general welfare of the blind, the first vital concern to which its attention was turned was that of types. Two important criteria were formulated, the first that the blind should be the judges--the sole judges--of what was best for them; the second, that the merits of the respective systems were to be settled only through direct acquaintance and not on theoretical grounds.
>
> Armitage in particular looked upon the dominance of institutions for the blind by people with sight as one of the chief causes of chaotic conditions and, while the association welcomed to its membership persons with sight, the Executive Council had to be composed wholly of those who must use the sense of touch in reading. While the general stand taken was based on sound principles, it ought to be noted in passing that this view may very easily lead to a social perversion and to absurdities in practice.
>
> The newly formed association began an exhaustive study of types. The line systems, except that of Moon, were condemned. The braille system was favored because (1) of the facility in writing it by means of the writing frame, (2) of ease in reading, and (3) of the possibility of saving space in writing by interlining. Orthographic correctness was also urged in its favor, though this is by no means the

peculiar property of braille. While the association had no official force and could not by mandate secure conformity with its decisions, its influence was very great. The year 1869 marks the beginning of better practice in the education of the British blind, and in their care as well. Slowly the institutions and schools discarded the older systems and braille was left without a rival. Only one other type was used to any extent, that of Moon. Once, indeed, the supremacy of braille was threatened by the introduction of the New York Point system, but after deliberating for two years, the association decided to adhere to the braille system.

For many years British educators were exercised over the question of uniformity in the writing of braille. As the system was extended, various methods for cutting down in space were attempted. There resulted contractions, abbreviations and similar devices, into which there crept in time such a lack of uniformity as to threaten the utility of the system. Constant agitation for many years led to the appointment of the British Braille Committee, which was charged with the revision of the braille system as used in Britain. It rendered its report in 1905. In what were termed "Grades I and II," it laid down the orthodox rules for the writing of braille. While not by any means perfect, the revision did secure uniformity, and its latest triumph was its virtual acceptance in America, resulting in a nearly uniform system for the English-speaking world.

The braille system was introduced into America about 1860. It was taught in the Missouri School for the Blind at St. Louis, where it was eagerly taken up by the pupils, who found it superior to the line systems. Why it should have remained for years in oblivion, it is hard to say. It had to make its way surreptitiously and was in general proscribed on the ground of its being arbitrary. Dr. T. Sibley of the Missouri school seems to have been the first American educator to recognize the merits of braille and extensively to advocate its use. By that time New York Point had made its appearance. Before many years the "battle of the points" was joined and even yet its smoke has not cleared away.

Its chronicle can be extracted from Irwin's "War of the Dots" as follows:

> In 1860, Dr. Simon Pollak, a member of the Board of the Missouri School for the Blind, who had observed the system in use in Europe, brought it back to America with him and caused it to be officially adopted by this school.
>
> Joel W. Smith, a blind piano tuning teacher at Perkins Institution for the Blind in Boston, felt that letters made in a cell three dots high and two dots wide could be read more easily and written more rapidly than Mr. Wait's New York Point system. In order to gain for a system written in the braille cell some of the advantages claimed for New York Point he worked out a rearrangement of Louis Braille's

characters. To save effort in writing he assigned the characters having the fewest dots to the letters recurring with the highest frequency in the English language. To keep down the bulkiness of embossed books he evolved a set of word contractions, assigning characters to them on the same frequency of recurrence principle. This new type he called Modified braille. Smith expounded his system before the American Association of Instructors of the Blind in 1878. However, New York Point was already the officially adopted type of the association. Mr. Wait and his friends gave the young mild-mannered Smith pretty harsh treatment at this meeting.

In 1890 there came onto the type scene as superintendent of the Pennsylvania Institution for the Instruction of the Blind in Philadelphia, a young man who was destined to play a stellar role in the whole type controversy. He was Edward E. Allen who had formerly taught in the Royal Normal College for the Blind in London where an English adaptation of Louis Braille's system was in use. From London he had gone to Boston as a teacher in Perkins Institution. There he became familiar with Smith's Modified braille which was in use for manuscript purposes. He liked the scientific basis on which ordinary lower case letters could be converted into capitals by prefixing two dots in the bottom of the preceding cell.

In 1892 a group of seven or more superintendents of schools for the blind met at the time of the Brantford, Ontario, convention of the American Association of Instructors of the Blind under the chairmanship of Michael Anagnos, Director of Perkins Institution. This group was dissatisfied with New York Point and decided to adopt some form of braille. They appointed a subcommittee consisting of Dr. John T. Sibley of the Missouri School for the Blind, Joel W. Smith and Edward E. Allen, to decide which braille alphabet to adopt in America. After some discussion, all but one, Dr. Sibley, decided to use Modified braille in spite of the fact that no books in this type were available. In 1900 this type was renamed American braille on the suggestion of Dr. Sibley.

At this time considerations regarding the mechanics of printing for the blind were interjected into the type question. So far, embossed Roman letters known as linetype, and New York Point had been printed with movable type from which stereotype plates were sometimes cast. In England braille books had been printed from metal sheets punched out on a rugged braille writing frame with a heavy stylus and mallet.

Modern printing for the blind may be said to have begun in 1892 when Frank H. Hall, superintendent of the Illinois School for the Blind, demonstrated his recently developed braille typewriter before the American Association of Instructors of the Blind at Brantford. This device tremendously speeded up the writing of braille. A good writer with a slate and stylus can seldom write more than from ten to twenty words a minute, whereas a proficient braille typewriter operator may, with a reasonable amount of practice, write two or three scores of words per minute.

From the development of a braille typewriter for writing on paper it was only a step to the development of a more powerful machine for embossing on sheets of brass, zinc or iron. This machine was called the braille stereo-typemaker and was exhibited at the Columbian Exposition in Chicago in 1893. The printing process was simple. The embossed metal sheets were covered with tough, heavy paper about twice the thickness of ordinary book paper, and upon this was laid a rubber blanket. The whole combination was then inserted in a press, and pressure applied. When the paper was removed, it was covered entirely with braille printing.

With the advent of Hall's stereotypemaker Mr. Allen set up a braille printing shop in his school in Philadelphia and several other schools followed, notably the Illinois School for the Blind. Embossed braille plates from these schools were sometimes deposited with the American Printing House for the Blind so that books could be made from them and sold to the various schools who wished to purchase them.

Mr. Wait after examining the braillewriter realized that New York Point was doomed unless an equivalent machine for writing his type could be perfected. He therefore went to work on this problem, and within a few months produced a typewriter for writing New York Point, which was christened the Kleidograph.

He had no sooner announced this machine than he had another surprise awaiting him, the braille stereotypemaker. Anyone who has had the experience of developing rather complicated mechanical appliances is amazed at the shortness of time that was required for adapting the Kleidograph to embossing on metal sheets. This extended the life of New York Point for another generation.

The advocates of the two rival systems worked hard at raising money from private as well as public sources to build up libraries in their favorite types.

In 1909 when plans were being made for the new day school classes for the blind in the New York Public Schools the thorny question of what tactile type to use in these classes came up for decision. There was so much feeling on the subject, especially in the city of New York where New York Point had its birth, that the Board of Education wisely decided to hold a public hearing and let the advocates of the two systems present their cases before a committee of the Board.

There were two hearings held, the first on March 24, the second on May 18. The time allotted to the first hearing was two and a half hours and was equally divided between the factions, New York Pointists having the first half. This gave the Point people no time for rebuttal and the protests were so violent that a second hearing was held.

William Bell Wait marshalled his witnesses in behalf of New York Point while Miss Winifred Holt, founder of the New York Association for the Blind, rallied the American braille forces. Behind this hearing, as the initiated realized, was a background of a long-standing feud between Miss Holt and Mr. Wait which had little or nothing to do with blind people's reading. Mr. Wait objected to Miss Holt's publicity methods, and Miss Holt was very critical of Mr. Wait's school for not taking more interest in the vocational prospects of its pupils.

Such authorities as Mr. Wait himself; Mr. John F. Bledsoe, Superintendent of the Maryland School for the Blind; Benjamin Berinstein who was then a young blind college student, and other New York Point stalwarts testified passionately in favor of New York Point.

Miss Holt persuaded such braillists as Frank H. Hall, inventor of the braillewriter, who long since had left work for the blind, to come to New York to testify. With him were such well-known personalities as George W. Jones, then superintendent of the Illinois School braille printing department and braille member of the Uniform Type Committee of the American Association of Workers for the Blind; Olin H. Burritt, then superintendent of the Pennsylvania Institution for the Instruction of the Blind; John B. Curtis, sightless supervisor of classes for the blind in the Chicago Public Schools, and others. Edward E. Allen, then director of Perkins Institution, was absent in Europe or he would doubtless have been one of the star witnesses.

Helen Keller, who has always avoided needlessly involving herself in controversies which might prove acrimonious, was not present, but she did write a letter to A. Emerson Palmer, Secretary of the New York Board of Education, which was read at the hearing.

The hall in which the hearing was held was packed to overflowing with backers of the two systems. Charles F. F. Campbell, son of the famous Sir Francis Campbell of the Royal Normal College for the Blind in London, England, and editor of the Outlook for the Blind, came down from Massachusetts with several others to witness the spectacle. A whole delegation came from Philadelphia, another from Baltimore, and local braille and New York Point fans listened eagerly.

Both sides stressed for the most part the economy and flexibility of their systems. In New York Point a given number of words occupies substantially less space than in American braille. Mr. Wait made the most of the spacesaving qualities of this type even to the point of exaggeration. He also directed attention to the fact that the available library of New York Point books was much larger than that in braille.

The advocates of American braille made a rather impressive showing by recounting the schools for the blind which had abandoned use of New York Point in favor of American braille indicating a strong trend toward the newer system. One of their strongest arguments was that, as New York Point publishers made little or no use of their cumbersome capitals or their four-dot long hyphens and apostrophes, most books were published without using any of these signs.

Studies based on tests made with a very few subjects claimed evidence in favor of braille, which was used effectively at the second hearing. However, the most telling blow that was given New York Point occurred at the first hearing. It was an exhibit offered by Frank Hall which showed two copies of a title page of a book in ink type, one entirely without caps as it would appear in New York Point and one correctly capitalized as it would appear in American braille.

Mr. Hall also showed an exhibit in ink type with apostrophes and hyphens omitted. Much was heard in those days of what was termed the "illiteracy" of New York Point which, when translated into ink type, made New York Point books look like very poor models of English to place in the hands of blind children.

Helen Keller's letter to Mr. Palmer summed up much of the argument in behalf of American braille. It reads as follows:

"New York Point is much harder for me to read than American braille. It wears my reading finger more to travel over letters three dots wide and two high as they are in New York Point than over letters two dots wide and three high as they are in American braille. Also, it is a most trying task to decipher many letters which I get in New York Point. The writers evidently have trouble either with the system or the machine. Of the letters I receive in the two systems, a far larger proportion are well written in American braille."

After mature deliberation the committee of the New York Board of Education finally handed down its decision in favor of American braille.

Most of the money for educational books for the blind comes from the United States Government. The federal appropriation for school books is made to the American Printing House for the Blind of Louisville, Kentucky. This institution, which is today the largest embossing plant for the blind in the world, is governed by a board of trustees on which the superintendent of every publicly-supported school for the blind in the United States is ex officio a member. In addition there are seven lay board members residing in Kentucky. From these lay members the president is invariably selected, and they constitute the executive committee which handles the day-to-day business of the institution.

As long as most of the superintendent board members were advocates of New York Point, they had been able to prevent any of the federal money being used for publishing in braille. This forced the schools using braille to rely upon private philanthropy, or upon state appropriations for their books.

In 1910, however, it was evident that the forces of New York Point and the braille advocates on the board were nearly equal in number. This resulted in what at the time looked like a smart maneuver on the part of New York Pointers to preserve the New York Point monopoly on government funds.

It had been customary, since 1880, for the American Printing House for the Blind to hold a meeting of its board of trustees at the same place and time as the biennial convention of the American Association of Instructors of the Blind. This saved the superintendents attending the conventions the expense of going to Louisville to attend the annual meeting of the Printing House those years. In 1910 nineteen of the superintendents of schools using braille petitioned Colonel Andrew Cowan, President of the American Printing House for the Blind, to hold its usual board meeting that year at Little Rock, Arkansas, immediately following the convention of the American Association of Instructors of the Blind. Shortly before Mr. Benjamin B. Huntoon, Superintendent and Secretary of the American Printing House, sent out a letter announcing that it had been found to be illegal for the American Printing House as a Kentucky corporation to hold its board meetings outside of the state. To the braillists this seemed to be a sharp move. Several of the superintendents lived on the Pacific Coast, and meeting the cost of going to Louisville from Little Rock would be a hardship for them.

When the superintendents gathered for the convention that year, emotions were running high.

Feeling ran so high that it was hard to find a member of the association whom they all could trust to preside. However, they finally selected a rugged old Hoosier, George Wilson, Superintendent of the Indiana School for the Blind, who had the reputation of rock-bound integrity. He professed to be entirely openminded on the subject of braille and New York Point. After careful study he had chosen for his school the braille system of music notation, while New York Point had been selected for literary purposes.

It was not an easy task to preside over this assembly. On one hand there was a group fearing that their favorite New York Point type was about to go down to defeat at the hands of an ill-advised group of newcomer braillists, and, on the other hand, a group of braillists who saw themselves about to be swindled by a technicality out of an opportunity to have government money made available for books in their type.

As the gentlemen assembled one could feel the tension in the air. It was decided that no questions would be barred at this meeting and that no punches would be pulled. Mr. Huntoon, who had exploded the legal bombshell, became both the target of criticism and the defender of the American Printing House for the Blind.

Everybody wanted the floor, so it was ruled by the chair that no one could speak more than once, until everybody else had had a chance. In fairness to the Printing House, it was also ruled that its superintendent might answer questions regardless of the number of times he had had the floor previously. Mr. Huntoon was, at that time, a zealous, elderly man who believed earnestly in New York Point. He was one of probably not more than ten per cent of the group who could personally read either system. As the author looks back on that meeting he remembers the eagerness of Mr. Huntoon to bring out certain points. Since he could not personally raise these points, except in answers to questions, he would appeal to the chair in his high-pitched voice to have someone ask him "the following question." Finally, Mr. Huntoon objected to one of the questions which seemed to reflect unfairly upon him and his institution. He said that he would not "waste his breath on a jackass like the questioner." The chairman ordered him to withdraw that remark or he would suspend the discussion immediately. After a tense minute or more, Mr. Huntoon rose slowly to his feel and said, "Having delivered myself of the epithet, I now gladly withdraw it." This broke the tension and the meeting burst into prolonged laughter which seemed to give everyone as much relief as Mr. Huntoon's epithet had afforded him.

As a result of the discussion the braillists all determined that they would attend the Louisville board meeting the following day even if they had to ride home on brake beams. A special sleeping car was reserved for them and the annual meeting at Louisville had a record attendance that year.

Regular business of the Louisville meeting was disposed of with the customary dullness that characterizes most annual board meetings. Finally, under new business, the motion for which everyone was waiting breathlessly was made, taking the form of a proposal that forty per cent of the government appropriation be expended on the publication of American braille books. The vote was a tie. This left it up to the chairman of the meeting, Colonel Andrew Cowan, a local businessman of very high repute, to cast the deciding vote. Mr. Huntoon implored him in a whisper to kill the motion. Colonel Cowan disappointed his New York Point friends by stating that the motion seemed like a reasonable request since forty per cent of the pupils represented by the superintendents were in schools which had officially adopted American braille. He cast the deciding vote in favor of the resolution, and one can easily imagine the chagrin of the New York Point members. From that time on, forty per cent of the federal appropriation went for American braille books until Revised braille completely supplanted both of the contending systems.

Meanwhile the blind people, who were the real sufferers as a result of the controversy, had become heartily disgusted with the fight going on between superintendents of schools for the blind, few of whom could read either system.

> In 1901 the American Blind People's Higher Education and General Improvement Association at its Kansas City convention passed a resolution which read as follows, "That a committee be appointed to investigate the various forms of tactile print, and to labor for the adoption of some one universal system."
>
> In 1902, pursuant to this resolution, the Tactile Print Investigating Commission was created, consisting of four members, and chaired by Ambrose M. Shotwell, a blind man who was braille printer of the Michigan School for the Blind and later braille printer and librarian of the Michigan Employment Institution for the Blind in Saginaw. A prominent member of the commission was John B. Curtis, also sightless, who was supervisor of classes for the blind in the Chicago Public Schools which operated a small braille printing shop.

At this point we turn to French for a succinct account of the denouement:

> The American Association of Workers for the Blind* had appointed a Uniform Type Committee which made a notable report in 1907, with recommendations for a further investigation and the raising of funds looking toward that end. The committee was continued from biennium to biennium, making reports and quietly and unostentatiously pushing forward the propaganda of uniformity. Even Mr. Wait now advanced in years and less likely than ever to look at the type question dispassionately, in his Examination of the Report of the Uniform Type Committee of June, 1913 (New York, 1915), gave due credit to the industry of the committee, though he at once flared up into a fiery denunciation of their findings that probably did more to injure the cause of New York Point than any other single act or utterance. These wrath-arousing recommendations, based on fairly exhaustive and apparently well-arranged reading tests, favored for literature and writing the British Braille alphabet, with the American Braille capital prefix, though they went further and urged the extension of base to a three-dot horizontal. Very wisely they left the matter open for further investigation. The report of the committee in 1915 was very extensive, covering elaborate tests. On the whole it adhered to the conclusions and recommendations of 1913.

Consider how the tables were turned as described by Robert Irwin. He shows us how braille, unofficial and rejected by school men, acquired a curious underground mystique as the preferred system of certain highly independent and gifted blind people. Helen Keller and Sir Francis Campbell were two. New York Point became associated with the rigid, the academic, the "scientific" approach to blindness; braille to the "human" approach. Here in retrospect emerges a most important aspect of the contention. The two systems were dot systems so similar their differences are of minor importance compared with the difference between both and all types of raised letters. But, in the long run, braille seems to have had just enough of an edge in its compression and its suitability to the fingertips to acquire for itself a slow-growing party of consumers and their friends in authority who led a counter-revolution which defeated New York Point and routed it utterly. There was no real detectable scientific reason for this. Many people, including blind people, believed to their graves New York Point was the better system. This remains a moot question to most who examine the existing evidence. There is one fact in the case, however, which is certain. It meant something, both for propaganda purposes and as an explanation of its peculiar suitability, that it had been devised by a blind man. Ladies and gentlemen of science, never ignore this factor.

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* formerly American Blind People's Higher Education and General Improvement Association

And heed what one of the keenest blind experts on touch reading wrote after attending the international conference which brought an end to the controversy. Louis Rodenberg, for 50 years superintendent of the braille print shop of the Illinois School for the Blind, was a man of technical skill, not given to impassioned writing, and he said:

> In no other land have there been such colossal, such costly, such convincing, experiments in finger-reading as in the United States. The blind of this country have paid in full. In some instances the experiments imposed on them were sheer theoretical projects devised by seeing workers. In other cases experiments were projected on them by persons who were themselves without sight. The superior legibility of obsolete American Braille and of surviving Standard English Braille may be traced to the fact that they orginated in blindness--which is proof that efficiency in solving problems of human suffering comes first from identity with that suffering. . . . It will not be necessary for us to review one hundred years of experimentation inflicted on American finger-readers who were yearning for and needing more literature and receiving less than they might have been--an appalling history of costly libraries built up, duplicated, and destroyed. The acceptance of Standard English Braille throughout the English-speaking world meant this long and extravagant experimentation has come to an end, has resulted in a definite idea, has the vast significance of establishing the universality of the braille principle; and all of this signifies the final triumph of the son of the harness maker of Coupvray. The name and fame of Louis Braille will now endure. Never, on entering a cathedral, did I have more strongly the sense of treading on holy ground than when I stopped to pass through the low doorway of the stone hut on the stony hillside of Coupvray beyond the Marne. From that lowly cradle came one whose idea was to have such singular value that, a century after its conception, it would be taken by determined men to the hilltops of the world as a perpetual boon to unfortunate people.

STANDARD ENGLISH BRAILLE
Complete Chart of Symbols and Contractions
American Braille Commission
1933-34

ALPHABETIC CHART OF CONTRACTIONS AND ABBREVIATIONS

about	⠁⠃
above	⠁⠃⠧
according	⠁⠉
across	⠁⠉⠗
after	⠁⠋
afterward	⠁⠋⠺
again	⠁⠛
against	⠁⠛⠌
ally	⠠⠽
almost	⠁⠇⠍
already	⠁⠇⠗
also	⠁⠇
although	⠁⠇⠹
altogether	⠁⠇⠞
always	⠁⠇⠺
ance	⠨⠑
and	⠯
ar	⠜
as	⠵
ation	⠠⠝
bb	⠆
be	⠆
because	⠆⠉
before	⠆⠋
behind	⠆⠓
below	⠆⠇
beneath	⠆⠝
beside	⠆⠎
between	⠆⠞
beyond	⠆⠽
ble	⠼
blind	⠃⠇
braille	⠃⠗⠇
but	⠃
by	⠴
can	⠉
cannot	⠘⠉
cc	⠒
ch	⠡
character	⠐⠡
child	⠡
children	⠡⠝
com	⠤
con	⠒
conceive	⠒⠉⠧
conceiving	⠒⠉⠧⠛
could	⠉⠙
day	⠐⠙
dd	⠲
deceive	⠙⠉⠧
deceiving	⠙⠉⠧⠛
declare	⠙⠉⠇
declaring	⠙⠉⠇⠛
dis	⠲
do	⠙
ea	⠂
ed	⠫
either	⠑⠊
en	⠢
ence	⠰⠑
enough	⠢
er	⠻
ever	⠐⠑
every	⠑
father	⠐⠋
ff	⠖
for	⠿
from	⠋
ful	⠸⠇
gg	⠶
gh	⠣
go	⠛
good	⠛⠙
great	⠛⠗⠞
had	⠸⠓
have	⠓
here	⠐⠓
herself	⠓⠻⠋
him	⠓⠍
himself	⠓⠍⠋
his	⠦
immediate	⠊⠍⠍
in	⠔
ing	⠬
into	⠔⠖
it	⠭
its	⠭⠎
itself	⠭⠋
ity	⠰⠽
just	⠚
know	⠐⠅
knowledge	⠅

less	⠨⠎
letter	⠇⠗
like	⠇
little	⠇⠇
lord	⠐⠇
many	⠸⠍
ment	⠰⠞
more	⠍
mother	⠐⠍
much	⠍⠡
must	⠍⠌
myself	⠍⠽⠋
name	⠐⠝
necessary	⠝⠑⠉
neither	⠝⠑⠊
ness	⠰⠎
not	⠝
o'clock	⠕⠄⠉
of	⠷
one	⠐⠕
oneself	⠐⠕⠋
ong	⠰⠛
ou	⠳
ought	⠐⠳
ound	⠨⠙
ount	⠨⠞
ourselves	⠳⠗⠧⠎
out	⠳
ow	⠪
paid	⠏⠙
part	⠐⠏
people	⠏
perceive	⠏⠻⠉⠧
perceiving	⠏⠻⠉⠧⠛
perhaps	⠏⠻⠓
quick	⠟⠅
quite	⠟
rather	⠗
receive	⠗⠉⠧
receiving	⠗⠉⠧⠛
rejoice	⠗⠚⠉
rejoicing	⠗⠚⠉⠛
right	⠐⠗
said	⠎⠙
sh	⠩
shall	⠩
should	⠩⠙
sion	⠨⠝
so	⠎
some	⠐⠎
spirit	⠸⠎
st	⠌
still	⠌
such	⠎⠡
th	⠹
that	⠞
the	⠮
their	⠸⠮
themselves	⠮⠍⠧⠎
there	⠐⠮
these	⠘⠮
this	⠹
those	⠘⠹
through	⠐⠹
thyself	⠹⠽⠋
time	⠐⠞
tion	⠰⠝
to	⠖
to-day	⠞⠕⠤⠙
together	⠞⠛⠗
to-morrow	⠞⠕⠤⠍
to-night	⠞⠕⠤⠝
under	⠐⠥
upon	⠘⠥
us	⠥
very	⠧
was	⠴
were	⠶
wh	⠱
where	⠐⠱
which	⠱
whose	⠘⠱
will	⠺
with	⠾
word	⠘⠺
work	⠐⠺
world	⠸⠺
would	⠺⠙
you	⠽
young	⠐⠽
your	⠽⠗
yourself	⠽⠗⠋
yourselves	⠽⠗⠧⠎

PUNCTUATION MARKS AND SPECIAL SIGNS

Capital sign	⠠
Comma	⠂
Semicolon	⠆
Colon	⠒
Period	⠲
Exclamation	⠖
Parenthesis (opening)	⠶
Parenthesis (closing)	⠶
Bracket (opening)	⠠⠶
Bracket (closing)	⠶⠄
Interrogation	⠦
Quotation (opening)	⠦
Quotation (closing)	⠴
Inner Quotation (opening)	⠠⠦
Inner Quotation (closing)	⠴⠄
Apostrophe	⠄
Hyphen	⠤
Dash	⠤⠤
Equals	⠒⠒
Asterisk	⠔⠔
Ellipsis	⠄⠄⠄
Accent Sign	⠈
Italic Sign	⠨
Letter Sign	⠰

Poetry line	⠜
Number sign	⠼
Decimal	⠨
Fraction line	⠌
Per cent	⠒⠏⠼
Dollars	⠲⠼
Cents	⠉⠼
Mills	⠍⠼
Pounds sterling	⠇⠼
Shillings	⠎⠼
Pence	⠙⠼
Francs	⠋⠗⠼
Marks	⠗⠍⠼
Pounds weight	⠇⠃⠼
Ounces	⠕⠵⠼
Tons	⠞⠼
Yards	⠽⠙⠼
Feet	⠋⠞⠼
Inches	⠔⠼
Gallons	⠛⠁⠇⠼
Quarts	⠟⠞⠼
Pints	⠏⠞⠼
Hours	⠓⠗⠼
Minutes	⠍⠔⠼

ACCENTED LETTERS
(French and Italian)

Cedilla C–ç	⠯
Acute E–é	⠿
Grave A–à	⠷
Grave E–è	⠮
Grave I–ì	⠌
Grave O–ò	⠬
Grave U–ù	⠾
Circumflex A–â	⠡
Circumflex E–ê	⠣
Circumflex I–î	⠩
Circumflex O–ô	⠹
Circumflex U–û	⠱
Diaeresis E–ë	⠫
Diaeresis I–ï	⠻
Diaeresis U–ü	⠳
Diphthong æ	⠜
Diphthong œ	⠪

(German)

Diaeresis A–ä	⠜
Diaeresis O–ö	⠪
Diaeresis U–ü	⠳

EXPERIENCE AND PLANS FOR EVALUATION OF SENSORY AIDS

- READING MACHINES -

34/35

EVALUATION OF CERTAIN READING AIDS FOR THE BLIND

Eugene F. Murphy

RCA A-2 READING AID

During the program of the Committee on Sensory Devices of the National Research Council late in World War II, and for some years thereafter, work was done at many laboratories on reading aids (as well as mobility devices) for the blind[14]. A major contributor was the Radio Corporation of America (RCA). Its so-called "reading pencil," the A-2 reader, was based upon direct translation of the shape of the letter into sound patterns by means of a scanning mirror, a single photocell, and an oscillating circuit whose frequency of output was related to the position of the scanning mirror and thus to the position where black was "seen" during movement of the probe over the letter Z. The result was a somewhat chirping or canary-like sound which was characteristic of each letter. After preliminary trials at Haskins Laboratories in New York City, a "production" version was built by RCA Camden Laboratories.

The Veterans Administration then arranged for evaluation of these models under Dr. Wilma Donahue, a psychologist, at the University of Michigan, Ann Arbor. She worked for several years, with the aid of a few assistants, in developing recorded training lessons and transition to manual tracking, and in training a series of congenitally blind and adventitiously blinded subjects of various ages.

Dr. Donahue's experiments indicated that several subjects were able to obtain moderate to substantial comprehension at successive speeds of 15, 22, and 36 words per minute (wpm) and peak speeds of 56 wpm, nearing the theoretical maximum for the oscillating scanning wave. A larger number of subjects were able to read at 15 wpm with the RCA A-2 reading device. Many subjects learned to operate the probe manually.

The A-2 device was quite portable. Wet storage batteries were used. Many sighted visitors were less impressed by engineering ingenuity or by the fact that subjects could read at all than by the seemingly very slow reading speeds obtained. Thus visitors to the project typically developed a rather cynical approach because the blind subjects had difficulty in reading strange materials such as the current issue of a magazine, even though they were able to decipher slowly material in the typewriter and book fonts and at the general level of difficulty of the lessons to which they had been exposed.

As some of her instructors left for other duties and Dr. Donahue herself shifted her interest to geriatric patients (thus soon becoming a well-known leader in the study of aging), the project gradually lost momentum. With some difficulty Dr. Donahue was able to assemble a relatively rough draft of a final report, primarily detailed appendixes on lesson plans and test data. Although this material is available in microfilm form from the National Library of Medicine, it has not been edited and published. Nevertheless the major conclusions may be stated as follows:

> Numerous subjects of varying ages, periods of blindness, causes of blindness, and occupations were able to learn to decipher typewritten and printed material, even though many of them had had no prior experience with printed letter shapes.
>
> Reading speeds, learning speeds, and comprehensions varied greatly but some subjects attained 93-100 per cent comprehension of new words at 36 wpm and 53-90 per cent comprehension at 56 wpm.
>
> Punctuation was readily and easily incorporated.
>
> Transfer to new styles of print caused little difficulty. The subjects were never able to identify isolated letters well; sentence reading was much easier.
>
> Transition from recorded, uniformly paced signals to direct signals (uniformly paced) and finally to manual tracking of the probe was accomplished reasonably readily.
>
> While all the subjects would prefer an instrument which permits more rapid reading, they felt that an instrument with a maximum reading speed of 30 to 40 wpm would be extremely useful.

After the University of Michigan project terminated, partly because of a shortage of funds, partly because of the criticism of some visitors to the project, and partly because of Dr. Donahue's new shift in interests, a blind person in the Michigan area wrote to the Veterans

Administration regretting closing of the project primarily because of the slow reading speeds attained. He suggested that speed alone was not the crucial problem compared with independence of reading, noting wistfully that even two words per minute would be faster than he could read independently!

READING MACHINE CONFERENCES

After the close of the University of Michigan project, reading machine development remained quiet for a few years aside from continued discussion among various blind individuals and sighted professionals. It became apparent that the Veterans Administration (VA) staff knew a number of people in many different related disciplines who did not yet know each other.

A technical conference on reading machines was arranged at the time of the Blinded Veterans Association in Toledo, Ohio, in August 1965, and a series of additional reading machines conferences was held at erratic intervals in later years. Typically each attendee was expected to pay his own transportation and subsistence without subsidy from VA. Nevertheless, attendance grew from 17 to approximately 50 or 60 and the mailing list for invitations and minutes to well over 100.

By the close of the fourth conference in 1956, it became apparent that there was general agreement on a broad analysis of the total problem of independent reading of ink print and typewritten material. There seemed needs for devices with either audible or tactile outputs and with a variety of systems representing various trade-offs between mechanical simplicity (and portability) and psychological simplicity (even if requiring library-type service). It seemed apparent that one could not obtain all the desirable features in a single device, but more specialized devices seemed feasible. Thus, there was general agreement on the value of trying again the simple so-called direct-translation device, translating the shape of the printed character into an auditory (or tactile) pattern varying with time and hence with position as the device was moved along the line. In spite of the expense of great psychological difficulties for the user, slow speed, and long training time, such simple approaches might have a place because of the potential relatively modest cost and minimal necessity for further invention to obtain an operable device suited to individual ownership, portability, and immediate, if limited, usefulness. Based on experience in teaching Morse code and on Dr. Donahue's efforts, development of training methods seemed possible.

At the other extreme, it was also apparent that a library-type reading aid might involve optical character-recognition equipment (then novel) and perhaps tapes that are used to control typesetting equipment, computer techniques, and very expensive equipment. Obviously a considerable research program in linguistics as well as in engineering would be needed to develop means for translating spelling of words into retrieval from a tape-recorded dictionary or into phonetic symbols and to devise means of synthesizing running speech. Such a nonportable library-type service, though, might also be worthwhile because of the speed of understanding running speech (even with an "accent") with no significant training. The Veterans Administration, therefore, suggested a series of proposals on various devices in the total matrix of possible designs. By great good fortune, a windfall occurred in the spring of 1957. Fortunately, it has been possible to fund a group of projects on reading aids ever since.

REVIVAL IN 1957

In the particular case of the simple direct-translation reading aid, with audible output on the optophone principle, a group of proposals was available. A proposal by Battelle Memorial Institute was recommended for implementation by an informal group of consultants, and Battelle was given a contract, first on a preliminary fixed-price basis in May 1957, and then for some years as a continuing research-type contract to develop a personal-type optophone and a training program. Much of the effort was devoted to development, testing, and refinement of teaching methods.

Initially, with the recommendation of the same group of consultants, Haskins Laboratories was given a fixed-price contract on an interim word-reading machine (on the "dictionary" principle) and soon thereafter a research-type contract, still continuing, on more basic development of rules and methods for speech synthesis. Such a library-type machine, only now being tested in partially simulated form, is at the opposite end of the spectrum in respect to technical complexity and first cost.

Mauch Laboratories of Dayton, Ohio, first was given a contract for an "intermediate-type" machine intended for personal ownership. The intention in 1957 was to try to combine the best features of the optophone and speech-synthesis types with audible output related to letter shape (without recognition) but sounding like a foreign language. After some years of vigorous efforts, Mauch Laboratories decided that this approach was unrealistic but that a relatively simple recognition-type machine producing "spelled-speech" (then being developed by Dr. Milton Metfessel under VA support) could be combined with a simple probe also useful independently for slower direct translation. (Further detail appears later.)

BATTELLE OPTOPHONE AND LESSONS

Much of the effort at Battelle was devoted to the development of a series of training lessons with the optophone code. A relatively small amount of effort was devoted to the design and construction of actual machines, although after preliminary efforts with an especially tuned electric organ (and later computer simulation) to experiment with various types of codes including numbers and frequencies of tones, Battelle built one or a few copies each of models A, B, and C. Model C was built under the sponsorship of the National Institutes of Health (NIH) in conjunction with a project to test young blind children. Eventually, under a separate subcontract, Aeronca built ten copies of Model D for the Veterans Administration.

Battelle devoted its initial efforts to training two subjects with Model A. One of them, Mr. Cobb, then a church organist and now retired, was allowed to keep a device and has remained a routine user. He still has a Model-D instrument which he uses both for his own purposes and for demonstrating occasionally to other blind people.

When Mr. Cobb was a student at Perkins School for the Blind in the early 1920s, the British Fournier d'Albe optophone in the production-engineered model built by Barr and Straud was demonstrated there. At the time, most observers understandably felt that it was hopelessly slow. At that time, of course, the electronic capabilities were very limited, so the machine was noisy and produced numerous extraneous signals. After his success in learning the Battelle optophone code in the late 1950s and early 1960s, eventually reaching a stage where he was timed at 19 wpm using a probe free hand and at 38 wpm when using the probe with a rather crude mechanical tracking aid, Mr. Cobb commented wistfully that he wondered what his life might have been like had he been able to continue to use a reading aid from the time of his school days. He found the aid useful not only for personal correspondence but for rereading an instruction book for the church organ which he played; incidentally, he found described in the book an extra stop of which he had been unaware.

A number of students at the Ohio School for the Blind were trained with the Battelle device, in successive models, primarily to help the Battelle psychologists develop their training lessons. These subjects were paid a modest hourly rate for their services but were not allowed to keep aids after the end of the school year. Initially a 65-lesson course was developed, then a 130-lesson course, and finally a 200-lesson course, with tests at the end of each ten lessons. It was apparent that subjects were still continuing to improve at the end of each course. Even at the end of the 200-lesson course, beginning with preprimer material, the subjects had only reached a few lessons of eighth-grade texts, including some typical Reader's Digest and other adult material.

It was apparent that reading speeds increased whenever subjects remained at a fixed level of difficulty for successive tests. Then, when the level of difficulty was increased, the speed apparently dropped, only to recover with the next test at the new level of difficulty, leading to a jagged learning curve. It was apparent that the curve for constant reading difficulty at each successive level was substantially parallel to those for lesser levels, leading to the presumption that prolonged training at a fixed level would indeed be effective in continuing to increase the reading speed. The better Battelle subjects reached approximately 15 wpm at the end of their training program, while the average was 10 wpm. It appeared that both the students from the School for the Blind and a group of five adult subjects, who were used with the final program, were able to learn the material. But, perhaps by coincidence, the men appeared to be more proficient than the women. There was some thought that the mechanical aptitude for tracking and manipulation might have been a factor.

Early in the Battelle program there was a test for recognition of isolated individual letters, with all 26 letters of the alphabet presented in random order plus randomly selected repetition of five letters, thus giving a total of 31 presentations. Though this test perhaps tended to emphasize slow, precise detection rather than reading of words and sentences in context, it may have merit for evaluation with skilled users. "Sociograms" based upon the errors made with these letters indicated that there were small clusters of common errors in detecting letters of similar shape such as lower case *b*, *h*, and *k*, or--in a separate cluster--*s*, *e*, *a*, and *c*, but there were no confusions between such separate groups. It was also apparent that a few letters such as lower-case *m* were immediately recognized with 100 per cent accuracy, but some other more difficult letters were only recognized with some 40-50 per cent accuracy. It was hoped that use of context normally would permit easy correction of such errors in comparison with the isolated letter presentation. For example, "tbe" or "tke" would be meaningless whereas "the" formed a very common word.

The Battelle training course attempted to combine the best features of word and sentence drill with carefully paced introduction of new letters and drill on detection of individual letters causing difficulty. Its chief weakness was use of elementary texts, boring to high-school students and adults.

When it became apparent that the ten Model D machines built by Aeronca would be available, the Veterans Administration asked for proposals on evaluation of the entire concept. The problem was discussed with a variety of agencies and individuals in psychology, education, rehabilitation, and work for the blind. With the aid of a group of consultants, the proposal from the American Center for Research in Blindness and Rehabilitation was selected and funded.

AMERICAN CENTER FOR RESEARCH IN BLINDNESS AND REHABILITATION

ACRIBAR initially expected to use an instructor who had been trained, with others, during the final week of the Battelle 200-lesson training course for five adult subjects. For family reasons she was no longer available when the project actually got under way. Another instructor was then given somewhat superficial training and pressed into service. The initial plan was to screen a group of subjects, then concentrate on the best.

Unfortunately, the two "best" subjects, after selection and a small amount of training, became increasingly unavailable. One moved from Boston to Washington, originally intending to stay only briefly, to continue his Battelle practice alone, and to visit Boston frequently for further lessons. Unfortunately, he became increasingly busy with other duties and decreasingly available. The second had a series of illnesses and hospitalizations, and finally died.

ACRIBAR continued for several years under contract, and still later on a voluntary basis to try to train additional subjects on a small scale. The project also provided some initial experience with the first Mauch Visotoners. The formal project, however, has terminated. The progress notes in the *Bulletin of Prosthetics Research* record the difficulties of this attempt at evaluation.

SOME PUBLICATIONS OF INTEREST TO THOSE CONCERNED WITH BLINDNESS

1. Bennett, Edward M., ed., HUMAN FACTORS IN TECHNOLOGY, McGraw-Hill Book Co., New York, 640 pp., 1962. [Chapters 17-25 deal with sensory supplementation, reading machines and guidance devices for the blind, information presentation to the blind, and the signals used by bats for a variety of tasks.]

2. Bernstock, William M., ed., "Bulletin of Prosthetics Research," Prosthetic and Sensory Aids Service, Veterans Administration, available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at nominal cost. [A semi-annual with first issue BPR 10-1 dated Spring 1964 generally containing some materials on sensory aids research.]

3. Carroll, Rev. Thomas J., BLINDNESS, WHAT IT IS, WHAT IT DOES, AND HOW TO LIVE WITH IT, Little, Brown and Co., Boston, 382 pp., 1961. [A comprehensive review of losses resulting from blindness and the possibilities of rehabilitation, with emphasis on the newly blinded adult.]

4. Clark, Leslie L., ed., "The Research Bulletin," American Foundation for the Blind, New York, issued about four times a year since 1962. [Designed particularly for researchers, this publication reports technical and scientific research of significance to the field.]

5. Clark, Leslie L., ed., PROCEEDINGS OF THE INTERNATIONAL CONGRESS ON TECHNOLOGY AND BLINDNESS, American Foundation for the Blind, New York, 4

vols., 1963. [A supplemented record of the Congress held at New York, June 18-22, 1962.]

6. Clark, Leslie L., ed., "Proceedings of the Rotterdam Mobility Research Conference," American Foundation for the Blind, New York, 294 pp., May 1965. [A record of the Conference held at Rotterdam, The Netherlands, August 3-7, 1964.]

7. Diamond, Isabella S., ed., "Blindness 1969," American Association of Workers for the Blind, Inc., Washington, D.C., annual, 207 pp., July 1969. [The sixth issue of this annual, earlier issues having come out each year since 1964.]

8. Griffin, Donald R., LISTENING IN THE DARK: THE ACOUSTIC ORIENTATION OF BATS AND MEN, Yale University Press, New Haven, 413 pp., 1958. [Note especially Chapter 12, "Echolocation by the Blind," pp. 297-322.]

9. Griffin, Donald R., "Echoes of Bats and Men: Seeing with Sound Waves," Science Study Series S-4, Anchor Books, Doubleday and Co., Inc., Garden City, N.Y., 156 pp., 1959. [Note especially Chapter 6, "Suppose You Were Blind," summarizing experiments on echolocation of obstacles.]

10. American Foundation for the Blind, Inc., "Research Index," a periodically updated three-volume set first issued December 31, 1967. Vol. 1: Introduction. Dictionary of Descriptors. Vol. 2: Scan-Column Index. Vol. 3: Bibliography.

11. Barnett, M. Robert, Ed.-in-Chief, "The New Outlook for the Blind," American Foundation for the Blind, Inc., 15 West 16 Street, New York, N.Y. 10011. [Published monthly except July and August in inkprint, braille, and recorded editions.]

12. Dufton, Richard, ed., PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SENSORY DEVICES FOR THE BLIND, St. Dunstan's, London, England, 477 pp., June 1966.

13. Lende, Helga, BOOKS ABOUT THE BLIND: A BIBLIOGRAPHICAL GUIDE TO LITERATURE RELATING TO THE BLIND, American Foundation for the Blind, New York, 357 pp., 1953. [Conceived as a classified compilation of special annotated bibliographies on various subjects relating to the blind. About 4200 references are included.]

14. Zahl, Paul A., ed., BLINDNESS: MODERN APPROACHES TO THE UNSEEN ENVIRONMENT, Princeton University Press, 576 pp., 1950. [Reprinted 1962 with bibliographic additions, Hafner Publishing Co., New York. In this book a very diverse group of experts, brought together by invitation of the National Research Council under the auspices of the U.S. Veterans Administration, join in discussing the problem of adjustment of the blind to life in the modern world.]

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EXPERIENCE IN EVALUATION OF THE VISOTONER

Howard Freiberger

Evaluation surely means many things to many people. By consulting the unabridged dictionary one can come upon the left-hand column of a matrix which expands the concept of evaluation, and then by considering the effects on individuals and groups one can derive the other column headings. On considering the elements in the matrix, Figure 1, one thus can see, for example, that among many other evaluation foci one element of interest is the *worth* of the device in question to the *individual* as a student.

e · val' u · ate	Individual					Other Individuals				Groups				
Examine; then judge, appraise, rate, interpret	Homo sap.	Student	Employee	Parent	Teacher	Neighbor	Associate	Employer	Stranger	Society	Agencies	Government	Research	Evaluate
significance														
worth														
quality														
condition														
amount														
degree														

Figure 1.

Mauch Laboratories has been a reading-machine development contractor of the Veterans Administration since 1958 aiming at designing a home-style reading machine of feasible cost. Several machines have been built and tried, but currently interest centers on the Visotoner, Visotactor, Cognodictor, and Digitactor. The Visotoner is in a sense an offshoot of the main thrust by Mauch to develop a recognition reading device that is simple, compact, and inexpensive enough to permit individuals to acquire and use it in their own homes and offices.

Based on British experience and results of trials with the VA-Battelle optophone, there seemed to be a need for a smaller, simpler audible-output direct-translation reading device. The Visotoner was produced to meet this need, six units being delivered to VA in May 1967 and 30 more in April 1969.

Mr. Harvey L. Lauer, a member of the staff of the Central Rehabilitation Section for Visually Impaired and Blinded Veterans, VA Hospital, Hines, Ill., was the first principal focus of VA efforts to evaluate polyphonic reading devices such as the Visotoner. He has since been joined in this effort by Miss Margaret Butow at the Hadley School for the Blind, Winnetka, Ill., and Mr. Richard Bennett, a VA staff member at the Western Blind Rehabilitation Center, VA Hospital, Palo Alto, Calif. These persons have been variously engaged in selecting, training, testing, and interviewing blind people who have associated themselves with the Visotoner in one way or another. Some work along these lines has also been done by Miss Mary Jameson of St. Dunstan's in England, and by Dr. Leo Riley at the American Center for Research in Blindness and Rehabilitation, Newton, Mass. Some of their evaluative findings have been reported in papers by Freiberger[1,2], and Lauer (Appendix E). Some of the material in these papers appears in Tables 1 and 2 which are based on data collected mostly by Mr. Lauer.

LITERATURE CITED

1. Freiberger, Howard, Reading Machines for the Blind, the Veterans Administration, and the Non-Veteran Blind, Report No. R-701204, 10 pp., typewritten and multilithed, Dec. 4, 1970.

2. Freiberger, Howard, Deployment of Reading Machines for the Blind, Bulletin of Prosthetics Research, BPR 10-15:144-156, Spring 1971.

Table 1.

SUMMARY OF REPORTED USES FOR THE VISOTONER READING MACHINE
SHOWING INITIALS OF USERS

USES	USERS				
Reads personal correspondence (typed)	RB MB	AC JC	MJ HL	CL SO	MC
Reads advertisements	RB HL				
Proofreads own typing	RB MB	JC MJ	DK TM	MM CW	MC HL
Picks up where left off when typing	MB HL				
Checks corrected typing (Korekto-type)	MB				
Reads labels	MB LH	HL			
Reads addresses on envelopes	MB MJ	HL			
Reads business correspondence	MB LH	MJ HL			
Reads directions or instructions	MB HL				
Locates place on form, letterhead, to type	MB HL				
Reads Bible	MC				
Reads magazines	MC JM				
Identifies things (printed or typed)	DK MM	HL			
Reads bills (gas, electric, telephone, etc.)	HL				
Reads bank statements	HL				
Reads forms	HL				
Identifies mail	CL HL				
Reads for pleasure - hobby	JM				
Reads wife's stories	JM				
Reads short articles	TM CW	HL			
Reads mimeographed college materials	SO				
Reads books	MC MJ				
Identifies paper money	HL MB				

Table 2.

SUBJECT	CITY	STATE	AGE	VOCATION	HADLEY COURSE	HINES TRAINING	EQUIPMENT		REPORTED USES	LEVEL ACHIEVED	EST. SPEED WPM
							VISO-TONER NO.	DATE ISSUED			
VETERANS											
A	San Jose	Calif.	48	Social worker	*	*	307	5/69	Personal correspondence, advertisements, typing	200 B lessons 1/70. Good ability, slow but accurate	15
B	Topeka	Kans.	43	Rehab. worker	*	*	306	10/69	Mainly for practice. Office correspondence, tape and record labels.	200 B lessons 2/70. Reads well a variety of print	
C	Tacoma	Wash.	28	Student		*	324	8/69	Checks typing, identifies things, conducts research study	140 B lessons	
D	Richmond	Ill.	50	Unempl.		*	325	5/69	Reads for pleasure. Magazines, wife's stories	200 B lessons 2/69. Much skill and persistence. Slow to learn code	12
E	Detroit	Mich.	30	Student		*	317	6/70	Checks typing, reads short articles. Lacks time to use extensively	200 B lessons 6/70. Useful skills	
F	Chicago	Ill.	24	Student		*	316	7/69	Reads his typing. Identifies some mail	80 B lessons. Reads simple materials slowly	
G	San Ant.	Tex.	33	Student		*	311	4/70	Reads incoming mail, mimeographed things from college	Excellent ability with code. 140 B lessons	
H	Okla.Cy.	Okla.	51	Unempl.		*	313	5/70	Reads amateur radio articles. Reads own typing, corresp.	190 B lessons. Reads good print slowly	
NON-VETERANS											
I	Winnetka	Ill.	33	Teacher	*	*	305	8/69	Correspondence, typing, labels, addresses, directions	200 B lessons 6/67	25
J	Wash.	D.C.	61	Teacher	*	*	308	9/69	Correspondence	160 B lessons 10/70. Reads good print slowly	
K	Akron	Ohio	71	Retired			Batt. D No. 5	7/65	Reads Bible, magazines, typewriting, books	200 B lessons	25
L	Laurel	Md.	30	Mathematician	*	*	314	5/70	Not efficient, but some mail and checked some typing	130 B lessons 10/70. Reads good print slowly	
M	London	Eng.	72	Reading Machines			030	2/69	Correspondence, typing, books, etc.	Pioneer in field with over 50 years of achievement	40
N	Hines	Ill.	37	Reading Machines	*	*	Several	Several	Correspondence, envelopes, bills, statements, forms, etc.	200 B lessons. Teaches skill, researcher, accomplished	40
O	Kalamazoo	Mich.	56	Teacher	*	*	034	8/70	Principally has potential as a teacher rather than user	60 B lessons. Only moderate ability with code. Has some vision	
P	Jacksonville	Ill.	53	Teacher	*	*	321	7/70	Identifies mail, reads some of it. Good potential instructor	200 B lessons 1/71. Reads well, difficulties caps and numerals	
Q	Birmingham	Eng.		Teacher	*		033	9/69	Reads primary school texts used by his class		
R	Cambridge	Mass.	53	Needlework			309	10/69	Has read newspapers and magazines.Learning bills & money	200 B lessons. 5.8, 6.7 wpm on tests 19 and 20	6

OPTACON EVALUATION CONSIDERATIONS

James C. Bliss

PAST AND ON-GOING OPTACON EVALUATIONS

It is impossible to separate the development of the Optacon from the evaluation of the Optacon as its design has evolved. From the outset Optacon development has been guided by concurrent experiments with blind readers. In the last three years, the development has also been guided by the performance and experience of five Optacon readers who have used various versions of the Optacon in their everyday lives. Results of performance tests, comments, and opinions of these individual Optacon readers have played a major role in determining the directions for continued development.

In addition, there has been a number of other evaluations outside our laboratory as shown in Table 1. These evaluations have been conducted over the past two years. Two different models of the Optacon were used in these evaluations and the earlier evaluations played an important role in determining the newer model of the Optacon used in the later evaluations. Also, these evaluations were used to develop and test instructional materials which have evolved to a well-developed state over this period.

From this experience we have increased our proficiency in conducting these evaluations and obtaining information from them. We now have well-developed, letter-recognition tests, reading-rate testing procedures, and questionnaires.

As a result of these tests and evaluations, a number of people have had access to an Optacon as if it were their own. In a recent survey we asked all of these people questions about their reading habits. Table 2 summarizes their replies. If the ultimate evaluation of an Optacon is whether or not blind people will use it, then the Optacon has already passed this test for these individuals.

IDEAS FOR THE NEXT STEP

Since several people now successfully use an Optacon, the objectives of an evaluation do not need to first determine whether or not it works, but rather more detailed questions need to be answered regarding cost/benefit trade-offs and characteristics of the population that can use the Optacon successfully.

TABLE 1

LIST OF OPTACON EVALUATIONS

Title	Who Conducted	When Conducted	Students Involved	Results	Method
Development Evaluations	Optacon Developers	1965-present	5 (varying in age from 15 to 32 yrs.)	Many Optacon design decisions based on experience. All good readers from 50 to 80 w.p.m.	1. Letter recognition measurements 2. Reading proficiency measurements
Monroe School	Optacon Developers	May-June 1970	6 (8-15 yrs. of age)	All learned to read with varying skill. Reported in New Outlook in May 1970.	1. Letter recognition measurements 2. Reading proficiency measurements 3. Instructor's evaluations
San Diego High School Living Skills Instruction	Blind Optacon Reader	Aug. 1970	4 (15-17 yrs. of age)	Letter recognition skills learned. Too short for much reading training.	1. Letter recognition measurements 2. Instructor's evaluations
Blind-Deaf Student	Blind Optacon Reader	Aug. 1970	1 (29 yrs. of age, total blindness-deafness)	Learned letter recognition well, but language deficiency hampered continued development in time available.	1. Instructor's evaluation
Berkeley Summer Program	Blind Optacon Reader	Aug. 1970	2 high school students	New instructional materials tested by inexperienced teachers. Both students learned to read	1. Letter recognition 2. Word reading 3. Reading proficiency 4. Weekly teachers' questionnaire; weekly teacher meetings
University of Oklahoma Sophomore	Optacon Developers	June-Aug. 1971	1 (College student)	New instructional materials tested. Reading rate of 30 w.p.m. achieved	1. Letter recognition 2. Word reading 3. Reading proficiency
The Seeing Eye, Inc.	Optacon Developers	Sept. 12-24, 1971	4 (26-51 yrs. of age)	Three students progressed to text reading, one through letter recognition. Preliminary Report available from TSI.	1. Letter recognition 2. Word reading 3. Reading proficiency 4. Student questionnaire 5. Teachers' evaluations 6. Follow-up student questionnaire 7. Follow-up Reading proficiency measurements
San Diego Unified School District	San Diego Unified School District	Oct. 1971 to Aug. 1972	5 (high school students)	Now in progress	

TABLE 2
OPTACON-USER SURVEY OF TOTAL
READING TIME DIVIDED BETWEEN VARIOUS READING METHODS

Name	Occupation	Began using Optacon in	% Time Using Tapes	% Time Using Braille	% Time Using Optacon
Candy Linvill	College Student	10/69	60	2	38
Sue Melrose	College Student	11/69	70	10	20
Loren Schoof	Research Associate	1/70	5-10	25-30	60-70
Tracy Reynolds	Junior High School Student	2/70	0	15	85
Bob Stearns	Computer Programmer	3/70	30	20	50
Hank Schriener	College Student	9/71	90	0	10
Karen Geyer	Teacher	9/71	33-1/3	33-1/3	33-1/3
Vito Proscia	Research Associate	9/71	0	40	60
Bob Weaver	Government Administrative Officer	9/71	100	0	0*
Bob Whitstock	Administrator	9/71	50	25	25

* Still receiving training

But more importantly, we are now at an opportune point to take actions which have a high probability of significantly increasing the independence of a segment of the blind population in a relatively short period of time. We think that taking these actions is not only important because they are likely to do the most good to blind individuals, but also because, if done properly, they will provide more evaluation information than the more classical critical approach. A few imaginative ideas for this positive approach are presented below. The first two ideas originated in an informal discussion at the National Academy of Sciences' Conference on Evaluation of Sensory Aids with Miss Josephine Taylor of the U.S. Office of Education.

Teacher-Training Programs

The introduction of the Optacon into college programs which train teachers of the visually handicapped would have several beneficial effects. It would provide information on the existing training materials, directions for improvement of these materials, familiarize teachers with the Optacon process, and enlist their help in establishing an appropriate deployment network. The teachers of the blind are the most important group in determining the extent in which the Optacon is deployed and they should be brought in at the earliest possible stage.

High-School Institutes

Every summer several programs are conducted across the country for the blind high-school graduates who are entering college in the fall. These programs would be ideal for conducting Optacon training classes. This group has a great need for reading the type of material the Optacon provides access to, it would be at a meaningful stage in their lives, and it may be possible to provide Optacons for them through existing rehabilitation programs. Providing Optacon training in these summer institutes would permit a great deal of evaluation data to be obtained in a short period of time. If this could be done in the summer of 1972 results could be available early in 1973, considerably ahead of the time schedule imposed by a more classical evaluation approach.

A Blind "Peace Corps"

As a follow-on of the above program (assuming a successful outcome), there could be a program in which blind college-age Optacon readers worked in Agencies for the Blind during their summers to help to diffuse the Optacon approach (as well as other sensory aid developments) into practice. If a national program could be instituted which would provide these young people to the agencies, at no cost to the agencies, and supply them with the materials and technological resources they needed, then we believe a great deal could be accomplished.

Many more programs can be thought of for various age groups, but these few give the flavor of a positive approach which emphasizes accomplishing the ultimate objective of increased independence of the blind. We believe this approach will also provide the most information related to evaluation objectives.

PLANS FOR THE EVALUATION OF A HIGH-PERFORMANCE READING MACHINE FOR THE BLIND

Franklin S. Cooper and Patrick W. Nye

Work on reading machines for the blind began at Haskins Laboratories during the last years of the Second World War[6]. Initial studies compared the readability of several non-speech codes with natural speech sounds. The results of this research indicated, on empirical grounds, that only a device which could produce spoken English would provide high reading rates and easy comprehension. Moreover, because speech output requires no training and a far smaller investment of interpretive effort than any other form of acoustic or tactile display, spoken material has a substantially greater chance of being successfully used by a commanding segment of the blind community.

Quite aside from these empirical data and other more basic arguments in favor of speech as an output medium, there is supporting evidence also from the practical experience which has accumulated over many years with non-speech direct translation devices. The Optophone[1] has been in almost daily use by Miss M. Jameson for 50 years. However, her best recorded reading rates have never exceeded 60 words per minute (wpm). One reader trained to read the Optacon's tactile output is reported to reach 70 wpm, while the Lexiphone claims one reader who can perform at 40 wpm. Average speaking rates, for comparison, are about 160 to 170 wpm, and few people have difficulty in understanding speech that is substantially faster than this.

EVALUATION OF WORD-BY-WORD COMPILATION

Beginning in the late 1950s and continuing to the present, work on a high-performance (i.e., speech) reading machine for the blind has been supported at Haskins Laboratories by the Veterans Administration. Several potential solutions to the speech generation problem have been explored. One simple and obvious way to generate speech is to compile, word by word, from recordings of individual words of the language. Correct pronunciation, clear articulation, and an even pleasant voice quality are important.

In the system built and tested at Haskins, a recorded dictionary of 7200 of the most frequently used words was employed, in addition to spoken letters of the alphabet[5]. As the incoming letter sequences of the printed text arrive, grouped into words, the appropriate outputs are sought in the dictionary and, if located, are delivered as word-by-word replayed speech. If a word is not available in the dictionary, it is heard in spelled form, letter by letter.

A series of laboratory and field tests have shown that such a system is, indeed, usable but that it has serious limitations. For example, the occasional incidence of a spelled word propagates disruptive effects upon comprehension. Readers, in their efforts to identify a word that is spelled, often become confused about the sense of the sentence and are obliged to replay it again. This effect, and the lack of smooth continuity in the flow of speech, led to disappointing overall results, although reading rates were still in the 100-150 wpm range. However, a better system had been found while this work was under way and, primarily for that reason, the use of compiled speech was abandoned.

PRELIMINARY EVALUATION OF SYNTHESIS BY RULE

Studies of the acoustic cues for speech perception made possible another and better approach to speech production. The key lay in the development of a simple set of rules whereby sequences of phonemes could be combined and the corresponding acoustic cues could be used to make intelligible speech[2]. Under computer control, the synthesis process can be carried out very rapidly[3,4].

During the past year, preliminary tests have been carried out on the acceptability of computer-generated speech to blinded veterans, and to blind university students as well. The results of these informal experiments have been most encouraging. The university students, who are strongly motivated, have been particularly helpful. In order to assess the educational value of synthetic speech as the principal medium of an automated reading service, it is crucial that the output be made available more rapidly and directly from normal printed and typed text. Thus, it is necessary to convert the research methodology into a fully automated production system. In the remainder of this paper we propose to describe the plans which have been drawn up by members of the University of Connecticut and Haskins Laboratories to use the synthesis system for the provision and evaluation of an automated reading service for blind students.

DESIGN OF A PRODUCTION SYSTEM

A precursor to the implementation of these plans is the development of a semi-automated system for the production of synthetic speech from typewritten text. Figure 1 shows the sequence of steps involved in text-to-speech conversion. The words which are recognized by the optical reader are recoded into phonemic form by means of a dictionary. The phonemic text is "punctuated" with stress and intonation instructions and then transformed by another program into instructions for the control of a speech synthesizer. Synthetic speech output from the synthesizer is then recorded on tape for use by the blind reader. A substantial part of this system--the speech synthesis procedure which embraces the last three steps of Figure 1--is already fully operational. Input to this completed portion of the system at present requires considerable hand labor. This work will of course be avoided when the first three stages, which are at present well in hand, are eventually made operational. We have completed a brief overview of all the stages involved in text-to-speech production. We will now describe the system in more detail. However, instead of commencing this description with the character-recognition stage, it will be more helpful to begin by explaining the operation of the synthesis portion of the laboratory system.

Speech Synthesis

Synthetic speech is currently being produced at Haskins Laboratories by a Honeywell DDP-224 computer which controls a hardware synthesizer. To make the machine speak, an expert phonetician must transliterate the printed text into a phonemic text and type it on a keyboard attached to the computer. Stress and intonation instructions are inserted to "punctuate" the phonemic text by means of a set of rules. The typed phonemic symbols and punctuation are then displayed on a storage oscilloscope which allows the operator to examine the computer's input instructions and to correct typographical errors if necessary. Using this phonemic input, the computer

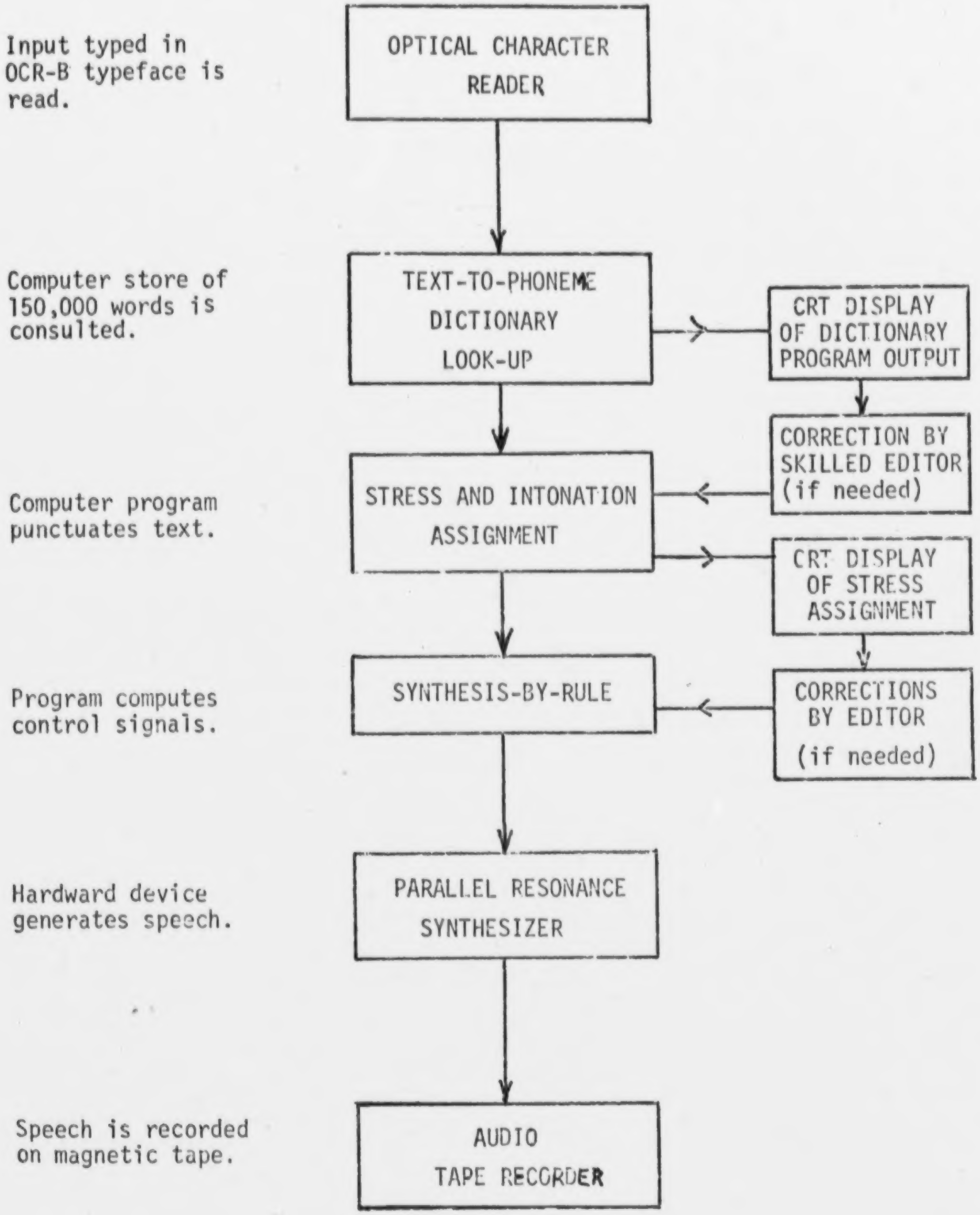
Input typed in OCR-B typeface is read.
OPTICAL CHARACTER READER
Computer store of 150,000 words is consulted.
TEXT-TO-PHONEME DICTIONARY LOOK-UP
CRT DISPLAY OF DICTIONARY PROGRAM OUTPUT
CORRECTION BY SKILLED EDITOR (if needed)
Computer program punctuates text.
STRESS AND INTONATION ASSIGNMENT
CRT DISPLAY OF STRESS ASSIGNMENT
Program computes control signals.
SYNTHESIS-BY-RULE
CORRECTIONS BY EDITOR (if needed)
Hardward device generates speech.
PARALLEL RESONANCE SYNTHESIZER
Speech is recorded on magnetic tape.
AUDIO TAPE RECORDER

Fig. 1. The Text-to-Speech Processor.

selects and combines groups of control parameters on the basis of programmed rules devised by Mattingly[4]. These control parameters are then fed to the synthesizer at a rate set by the operator. In practice speech can be generated at speaking rates from 60 wpm to over 300 wpm. However, without prior preparation, a passage of speech lasting for ten minutes at a normal presentation rate may take the phonetic typist as long as an hour to prepare. The way in which we propose to avoid the excessive labor and delay involves the addition of three major component steps which, although not totally eliminating the need for a phonetic typist, certainly should greatly speed the work of transliteration. These steps will enable us to generate the relatively large volumes of reading material required to provide a reading service.

Optical-Character Recognition

The first step employs an Optical-Character Recognition (OCR) machine. We plan to have text material retyped in an OCR-B typeface and read by one of the smaller limited-font OCR readers. The output will be recorded on digital magnetic tape for subsequent use by the computer. There are several sound reasons why we prefer to use even a single-font optical reader for input rather than provide text input via an on-line typewriter or punched paper tape. The first reason is that much larger volumes of reading matter than we have used before must be fed into the computer as rapidly as possible. A good typist can typically work on straightforward text more rapidly and accurately than a key-punch operator. Moreover, if her work is performed off-line, she need not occupy the computer unnecessarily during the text production process. Once a large volume of typescript has been prepared, an OCR reader can convert it into an alphanumeric code expeditiously and cheaply. A second reason for our interest in OCR input lies in a desire to gather some experience of current OCR technology so that we can better judge which machines and techniques best meet the needs of blind people. It is already apparent that the specifications of OCR devices designed for commercial applications do not fully satisfy the requirements of reading machines for the blind. For example, almost all of the commercial multifont OCR development is geared toward high-speed and high-accuracy operation on an input medium which is closely specified as to several of the following features; size and shape of the page, color, type style, print quality, and often the position of the printed text within the page. In contrast a reading machine for the blind must accommodate a flexible range of each of these input parameters. It is possible that by deliberate design this flexibility could be gained at the expense of some unnecessary accuracy. This is an area in which it is unlikely that the commercial sector will show interest. Furthermore it illustrates just one of the unique problems encountered in the application of optical readers to the field of blindness. The remedy can only be sought by those who have a direct interest in the eventual development of automated reading services.

Dictionary Development

The second step required to speed our production of reading materials is the development of a system for converting the alphabetic representation of each word into its corresponding phonemic representation. In the compilation of our now completed dictionary we are greatly indebted to the work of Dr. June Shoup of the Speech Communications Research Laboratory. The routine service programs for searching the word lists are in hand but not yet completed. When this work is finished the output from the dictionary will be displayed on a storage oscilloscope under the observation of an editor-phonetician. Corrections will be made, if needed, by the editor who will also note the circumstances in which errors occur. By this procedure we expect to produce useful text and at the same time detect defects in the search program or omissions in the dictionary and readily correct them. The dictionary we expect to use will initially include approximately 150,000 words, but this number may have to be significantly increased. The final size of the dictionary we need can best be arrived at through actual use in a practical production system. New entries can be added as they become necessary. Throughout this process a careful watch will have to be maintained over the system's performance to ensure a proper balance between the size of the dictionary and an acceptable search time or production rate.

Stress and Intonation Assignment

Following its assembly by the dictionary search routine, the phonemic string will be punctuated with stress and intonation symbols by a program based on a system of rules.

The combination of string and stress markings on phonemes will then be processed by the synthesis program which was mentioned previously. Finally, the computed control parameters will be converted to synthetic speech and recorded.

THE NEED FOR EVALUATION

Thus far we have described the production system which we require in order to generate synthetic speech from text in sufficient quantity to meet the needs of an evaluation study. The questions that the study will attempt to answer relate to human factors, costs versus benefit, and technical matters. However, before proceeding to a discussion of these questions in more detail, there is a prior question which should be raised and answered. Why should a reading machine generating synthetic speech be evaluated now? Step by step the answering argument is the following: First, synthetic speech, although not yet perfectly natural, is nevertheless intelligible to people who have received no prior exposure to synthetic speech or training in its use. Moreover, this is true of synthetic speech delivered at rates in excess of 150 wpm. No other reading medium intended for use by the blind either in process of development or deployment can make such a claim. It could be argued, therefore, that synthetic speech has, at the very least, an equal claim on the resources for deployment when compared with the generally slower auditory and tactile media. Second, there is a pressing need in the blind community (particularly among students) for an increase in the supply and speed of delivery of spoken text. A reading machine is ideally suited to the task of producing large volumes of material quickly and could fill the gap in present services by supplementing the material produced by human readers. Third, although synthetic speech appears at present to be at an economic disadvantage when compared with naturally produced speech, the costs of operating reading machines can be expected to fall in the future whereas human labor costs will certainly increase. The eventual economic use of reading machines is therefore inevitable. This conclusion leads to our fourth point which is that the initial entry of automated techniques into any new arena can always be expected to be met by new and often unforeseen problems. These problems are usually amenable to solution, but they first need to be identified. Time then must be allowed to find ways of circumventing each difficulty. Direct contact with the user population under field-trial conditions is essential. In the remainder of this paper we propose to outline the type of field trial which we believe to be required before we can prudently proceed to the actual deployment of an operating self-contained Reading Service Center on the University of Connecticut campus.

THE EVALUATION PLAN

The purpose of the trial is to provide answers to a number of questions which revolve around one central issue. Is the operation of a Reading Service Center economically feasible? This is not an easy question to answer in clear-cut terms because of the intangible human values involved, but it is obvious that we need to identify costs and benefits as accurately as possible and assess them in relation to available resources. To find the answers we need, we propose to operate a partial reading-machine service for the blind students at the university using the production system we have just described. Actual reading assignments required by the students will be transcribed into synthetic speech and supplied in the same way as existing services operated at the university provide natural-speech recordings. By examining the operation of this partially simulated Reading Machine Service we expect to find the answers to two broad classes of questions: the first relates to human factors, the second to technical and economic factors.

In the area of human factors we are concerned with the relative comprehensibility of synthetic speech and natural speech over a range of delivery rates. We are directing our inquiry to university students and the key question here is whether any differences in comprehensibility that may emerge are significant enough to affect the educational utility of synthetic speech. The basic strategy for assessing comprehensibility involves the presentation of a lively passage of general interest followed by a series of questions which seek measures of the number of facts retained (i.e., names, places, distances, colors, etc.), and also the ability of the reader to derive logical inferences from the information. We propose to apply such tests in synthetic speech and others of equal difficulty in natural speech (with appropriate counterbalancing) and then to compare the performance of the students. In a series of interviews designed to assess acceptability, we plan to gather data on such subjective factors as the relative preference for synthetic speech versus natural speech, the comparative comfort in use of the media, judgments regarding the aptness of different media for various fields of study, and the influence of delivery rate on all of these factors.

In the area of technical factors we are concerned with establishing an accurate assessment of the likely overall demand that a Service Center will be required to meet, the technical quality of the synthetic speech medium required to produce acceptable performance at reasonable cost, the turnaround time which is both acceptable and economic, and the range of speaking rate required of the output. From these data an optimum equipment configuration can be determined and labor and operating costs can be assessed.

In this paper, we have argued that in order to provide better educational, vocational, and recreational opportunities for the blind population of this country, faster and more flexible reading services are required. Moreover, the technical resources are now available to supplement existing services through the use of reading machines located in Reading Service Centers. We believe that the time is now right to make a determined effort to move this technical capability out of the laboratory and into the community it could serve. The evaluative work we have proposed here is extensive and time-consuming. Nevertheless, we maintain that there is simply no other prudent way of pioneering the application of a laboratory-developed technology to a socio-educational problem as complex as blindness, or arranging for its deployment in a community so diverse as that of the blind.

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A DIGITAL SPELLED-SPEECH READING MACHINE FOR THE BLIND

M. P. Beddoes, R. G. George, T. R. Fletcher, and C. Y. Suen

The purpose of our work is the development of a reading machine for the blind which strikes a reasonable compromise between expense and ease of use. The simple machines such as the Optophone and the Lexiphone are relatively cheap to produce but upwards of a year is required for the user to master an auditory code. The reading machine described here uses the one-to-one correspondence between spelled-speech utterances and the visual alphabet symbols. Although this machine is about two to three times more complex and expensive than the Lexiphone, it will appeal to many blind users for one principal reason; the spelled-speech code can be used after a few contact hours instead of the year or so to master the auditory code for the simple machine.

The machine described in this paper uses digital circuits. The letter-recognition problem and the method of storing spelled-speech sounds are described.

THE LETTER RECOGNIZER

The Lexiphone[1] contains a column of 54 cells which are arranged to scan a little more than the height of a line of print. This column is pulled by hand across the line of print, and signals are obtained from the cells as they pass over each of the letters in turn. From these signals a set of features are obtained which are size and registration invariant. These features are used to identify the letter. The first feature is the outline count in a vertical direction (V3) which is obtained by a simple manipulation of the 54 signals (Fig. 1). The second feature is the outline count in a horizontal direction (H2). The count vectors for a particular letter are compared to a stored set located in "read only" memory banks using a number of matching techniques. The results of these techniques using the 60-character set "Hermes Ambassador" are shown in Table 1. Twelve alphabet sets were used to train the recognizer and 12 other alphabet sets were used to test the recognizer.

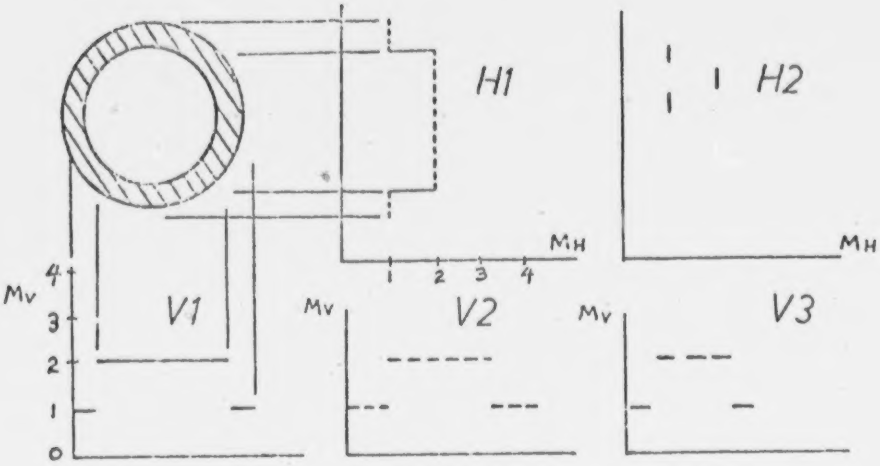

Fig. 1. Illustrating the formation of the vertical and horizontal feature vectors for the letter "o."

Table 1.

RECOGNITION ACCURACY USING VECTORS V3 AND H2 AND TECHNIQUES CD AND TREE

	Column 1 EM (V3)	Column 2 EM,CD(V3)	Column 3 EM,CD(V3) & EM (H2)	Column 4 EM, CD, TREE (V3)	Column 5 EM,CD,TREE (V3)&EM(H2)
Correct	50.0	52.3	77.2	80.0	93.3
Substitutions	30.0	45.5	21.4	16.0	6.4
Rejects	20.0	2.2	1.4	4.0	0.3

Column 1 shows the results of exact match (EM) for the vertical vector (V3). The results are poor; 50 per cent are identified correctly; 30 per cent of the letters are identified incorrectly (substitutions); and the remaining 20 per cent are rejected as being outside the training set. In column 2, using still only V3, a nearest neighbor's approach was used (called CD) in addition to the EM approach. Rejects are drastically reduced with some accompanying increase in substitution errors. A special technique, TREE[2], further improves the performance by increasing the resolution for many of the small letters. Best results are contained in column 5 using vertical V3 and horizontal H2 vectors with principal weight given to V3.

Table 2.

RECOGNITION OF FOUR DIFFERENT TYPE STYLES

Type Style	HA	SP	SC	SD
% Correct	95	94	92	90

Table 2 gives the results with four different type styles (all with serifs): Hermes Ambassador (HA), Pica 72 code 008 10 pitch (SP), Carrier 72 code 015 10 pitch (SC), and Delegate code 070 10 pitch (SD).

It must be emphasized that the figures in Tables 1 and 2 were obtained from material actually typed with normal typewriters, and errors induced in the print and in the optical reading systems of the Lexiphone are included.

SPELLED-SPEECH GENERATOR

The spelled-speech letters are stored as digital samples of a waveform (7KHz sampling rate, 3.5 KHz bandwidth). In one method, 4-bit samples were used and a time compression of a factor by two was employed in order to minimize the number of samples and increase the speed. Even so, the number of bits needed to represent the alphabet is quite large--92K; further, the durations (T_L) which were adjusted by ear do not approach making the product of P_L and T_L equal a constant. (Compare columns 3 and 4 in Table 3.) The price of using the "natural" code is that one is not free to minimize even first-order entropy. The larger number of samples is crippling from the point of expense.

Table 3.

LETTER AND LETTER SAMPLES FOR COMPRESSED BY TWO SPELLED SPEECH
(REPRESENTATIVE VALUES ONLY)

Letter	Samples	Duration (ms, T_L)	Probability P_L
a	579	89	.063
b	579	89	.01
v	771	119	.008
space	-	-	.2

It was suggested that spelled-speech letters contain periodic parts (the vowels and the liquids) and that compression could be achieved by repeating only a fundamental period[3]. The compression using this basic idea is very large indeed. Table 4 lists the basic sounds (whether or not they are repeated, as shown in column 2); and shows how the alphabet letters are produced from this basic set of sounds. Six-bit samples are permissible with only 23.5K bits of memory.

Table 4.

BASIC SOUNDS AND SPELLED-SPEECH LETTERS

Letter as in sound		Repeat (times)	Samples	Letter	Letter Sound
e	locate	17	32	A	e-
b	bit	1	122	B	bi-
s	sit	1	600	C	sii-
d	did	1	162	D	dii-
i	beet	11	35	E	iii-
ɛ	bet	17	35	F	ɛv-
g	jet	1	314	G	gi-
a	calm	21	33	H	eg-
k	kid	1	474	I	ae-
l	alone	10	34	J	ge-
m	among	10	36	K	ke-
n	annoy	10	36	L	ɛl-
o	oration	16	38	M	ɛm-
p	pay	1	314	N	ɛn-
q	quite	1	314	O	o-
t	tidy	1	378	P	pe-
u	book	16	30	Q	qu-
v	very	1	314	R	ap-
w	weak	1	442	S	ɛs-
-		Letter	Space	T	tee-
				U	iu-
				V	vii-
				W	w-
				X	ɛks-
				Y	wai-
				Z	sɛd-

CONCLUSIONS

A relatively cheap letter recognizer has been described which will give between 90 and 95-per-cent accuracy with well-typed material. The recognizer is suited to the simple column scanner presently used in the Lexiphone. The amount of memory needed to store letter information for the tests described is of the order of 12K bits and this is a principal item.

The spelled-speech generator uses digital samples of the waveform. Using the fact that parts of speech are periodic, very large compression is possible and the amount of memory needed to store the alphabet letters is 23.6K bits.

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EXPERIENCE AND PLANS FOR EVALUATION OF SENSORY AIDS

- MOBILITY AIDS -

10/71

THE VA-BIONIC LASER CANE FOR THE BLIND*

Eugene F. Murphy

The VA-Bionic laser cane for the blind is currently available in ten copies which are about to be given a preliminary evaluation at Hines and Palo Alto VA hospitals. Five weeks of training and tests of eight selected blinded veterans will ~~be~~ followed by approximately nine months of hometown comparative use of the laser and the conventional canes by these veterans. The evaluation plan has been developed with advice of a panel under the chairmanship of Dr. Patrick Nye of the Subcommittee on Sensory Aids of the National Research Council. The laser cane is only one of a number of developments made under the sponsorship of the Veterans Administration in an effort to improve the mobility of the blind.

HISTORY

The laser cane represents the culmination of an interest for more than two decades in problems of mobility for the blind on the part of the Veterans Administration. This work has been summarized in an article by Benjamin[4] and details have been reported in Bionic Instruments progress reports[5,6], companion reports by TRACOR[12] on the evaluation of an earlier Bionic device, and related papers by Riley, et al.[10] on the evaluation of early models of the Kay Ultrasonic Torch.

During World War II the wartime Office of Scientific Research and Development stimulated creation of the National Research Council's Committee on Sensory Devices, later supported by the Veterans Administration. As a part of its efforts on mobility, there were three attempts at ultrasonic object detectors under Brush Development, Hoover, and Stromberg-Carlson. Likewise the Army supported the development of the Signal Corps mobility aid designed by Lawrence Cranberg using optical triangulation by visible light. All of these received some preliminary trials at Haskins Laboratories[9].

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* Delivered at the July 19, 1971, meeting of the American Association of Workers for the Blind, Richmond, Va. Reprinted by permission.

Beginning about 1950 a production-engineered model of the Army Signal Corps device, built by RCA, was tested in multiple copies by Prof. Thomas A. Benham of Haverford College, in a field trial involving ultimately about 60 people[2]. This aid appeared to be useful for the detection of objects and obstacles straight ahead. If it were tilted downward, it could measure the slant height to the ground and thus detect curbs by the sudden increase in the distance to the ground. There were difficulties, however, because of the vertical oscillation of the body of the user during walking, the swinging of his arms, and the distraction caused by a constant signal which changed rhythmically during walking and yet whose sudden change was supposed to detect a curb. Many blind users objected to the constant presence of the signal. Professor Benham, in a paper presented at the 1953 annual convention of the American Association for the Advancement of Science[3], summarized the results of the evaluation and gave recommendations for improved models.

The Veterans Administration then embarked in a long period of development to try to achieve these goals. Work was done first under a VA contract with Haverford College which in turn used the then Biophysical Instruments, later organized as Biophysical Electronics and still later as Bionic Instruments, as a subcontractor. Later a direct contract was made with Bionic Instruments.

Out of this project eventually arose the Bionic Instruments G-5 object detector, somewhat like a lunchbox. Though it made no pretense to step-down detection, it appeared quite reliable at detecting objects ahead of the user when carried at his side. This device used flashes of light from an EG&G flashlamp to perform detection of obstacles by optical triangulation, a principle which after much study by Bionic Instruments seems to remain the most versatile method.

The G-5 device was evaluated in ten copies by TRACOR of Austin, Texas, with the cooperation of Professor Worchel of the University of Texas, a psychologist long interested in mobility problems of the blind[13]. It became apparent that subjects were happy to be able to explore and identify objects beyond arm's length. This new ability tended to enrich their knowledge of environment. Some congenitally blind subjects were particularly fascinated to discover, for example, that chandeliers hung downward from the ceiling which they had always presumed was flat and featureless. Though this richer appreciation tended to slow their passage through an obstacle course or a busy street, nevertheless a retest of available subjects showed that, if urged to do so, they could move rapidly. By merely looking for openings without identification of the bordering obstacles, they could go through obstacle courses with the same speed and with no more errors than with the conventional cane or guide dog. Indeed, those subjects who claimed to travel unaided (but probably actually used the elbow of a sighted friend a good deal of the time) were able to go through the obstacle course with dramatically fewer errors than in a completely unaided condition.

Shortly afterward the gallium-arsenide light emitters, about the size of a transistor case, became available. They were immediately used by Bionic Instruments to develop a flashlight-shaped object detector. Without a ranging feature, this was merely intended for limited local protection during travel on level and familiar ground while serving as a test vehicle for development of circuitry.

Still later, in 1966, true gallium-arsenide lasers operating at room temperature became available and were promptly used by Bionic to build a series of devices in cane configuration with three optical triangulation systems, culminating in the C-4 cane currently being tested. The goal was to keep the proven value of the long cane while supplementing its shortcomings.

THE C-4 CANE

In the C-4 cane, one of the laser beams of invisible infrared light shines upward so that its companion photocell, "looking" upward from a lower point on the cane shaft, can detect reflections from overhead obstacles which would otherwise strike the chest, head, or shoulders of the cane user. Protection is thus afforded against objects above the cane handle which normally can only be detected by echo location if the cane is used in the orthodox fashion with its tip on or near the ground (rather than swung in an unsocial saber fashion).

A second beam and its associated photocell project their detection area forward to give distant early warning of obstacles out to about 12 ft., equivalent to an impracticably long mechanical cane and useful both to identify distant landmarks while crossing a street or parking lot and to detect pedestrians or window-shoppers without mechanically rapping their shins.

The third beam points forward and downward to identify major discontinuities in the terrain such as the edge of a subway platform, a descending flight of stairs, or other major drop-offs. As yet it is not sufficiently sensitive to detect ordinary small curbs, which still must be located by loss of mechanical contact in conventional long-cane technique. It is hypothesized, however, that some blind users will be able to walk more confidently and in a more relaxed fashion if they have some assurance of warning against major hazards (from which ready recovery would be difficult) if warned about them while still about two cane lengths ahead.

The Bionic Instruments designers assumed that the middle or forward-looking beam would give the most frequent signals, so they provided a tactile stimulation consisting of a pin vibrating against the index finger of the hand holding the cane. This nonaudible signal normally would be detected only by the user. The other two signals typically occur much less frequently and are given by an audible tone from a small loudspeaker in the end of the crook in the cane handle. Overhead obstacles are signaled by a high-pitched tone, while major drop-offs are indicated by a low-pitched tone.

Recently the evaluating team has suggested that an intermediate tone might be desirable instead of or as a supplement to the tactile stimulation, so Bionic Instruments has modified the canes currently being tested to allow direct comparison of the usefulness of tactile and audible signals. Preliminary experience indicates that availability of both tactile and auditory signals is needed, e.g., noisy vs. quiet locations.

The canes had already been modified so that the signals being given to the user by the three channels could be presented through a telemetering system (carried by the user and plugged into the same jack used for recharging the nickel-cadmium batteries) conveyed to a small FM radio carried by a mobility instructor observing from a distance. It is thus possible, for example, to detect the first point at which the signal is presented and thus to measure the reaction time and the distance traveled by the subject before he stops or otherwise shows that he has detected a hazard. (The safety of the blind subject can also be increased during training by protection against possible faulty operations which could be detected by the instructor through the telemetering system.)

UNEXPECTED PROTECTION VS. "FALSE ALARMS"

It should be noted that a photocell responds in the same way, giving its characteristic output signal, whenever it detects laser light within its field of view and during the time it is "turned on" or "gated" to match the brief pulse of laser light. There are possibilities, as shown by a detailed study of the geometry of the beams and fields of view of the photocells, that one laser will cause a spot of invisible infrared light on a target within the field of view of a cell other than the one with which that laser normally cooperates. Thus certain nearby objects may be detected if one is aware of the subtleties of the system, yet the inexperienced or untrained user may initially be bewildered by apparent false alarms. Advanced training in these possibilities should of course follow the conventional training in which the beams are stimulated in their normal functions. An instructor fully understanding these possibilities will realize that they provide useful information, not false alarms.

LASER SAFETY

The concept of a laser, of course, immediately causes concern about safety aspects. There has been so much discussion of high-powered lasers for the cutting of metals and the welding of retinas for retinal detachment that the general public is concerned about laser safety. There is an increasing number of attempts to develop codes and legal regulations. Bionic Instruments has duly registered as a laser-device manufacturer in the state of Pennsylvania. The present author has attended the Second International Laser Safety Conference at the University of Cincinnati in 1969 and the Conference on Safety of Lasers, Microwaves, and Ultraviolet Radiation, also conducted by the University of Cincinnati, in 1971. He has talked with a great variety of experts in government, universities, research institutions, and industry. The consensus has been overwhelmingly reassuring.

The laser and drive circuit used by Bionic have been tested by the Air Force[11] and complete laser canes have been tested by two units of the Army as well as by the University of Cincinnati Laser Laboratory[7] with the cooperation of the Medical College of Virginia. The testing program has included both physical measurements of strength and divergence of the beam and prolonged exposure in monkey eyes. No damage has been found in the biological tests. The physical tests typically indicate intensities slightly above a threshold which has been tentatively set on a very conservative basis but well below the calculated equivalent of the threshold at which any biological damage has ever been found with other, far more powerful, and more "coherent" lasers of different types. A testing program has also been carried out by the United States Public Health Service on an actual laser cane, but the formal report is not yet available.

Informal discussions with those conducting all these tests seemed to indicate no cause for alarm with the VA-Bionic laser cane. It is an interesting observation that those concerned with laser safety have never bothered to establish standards for gallium-arsenide radiation at room temperature because it has never appeared to be hazardous. Thus, any thresholds which have been suggested have been obtained with great margins of safety, simply by extrapolation from the much more hazardous types of lasers which have deservedly attracted greater attention.

EVALUATION

As a first step toward evaluation it seemed desirable to gain the opinions of skilled mobility therapists. The next step was to develop new teaching techniques based upon modifications of conventional long-cane therapy. Then the goal is to have selected blind persons with above-average mobility skills receive special training and experiment with the cane. It is recognized that there are so many variables in the field that one cannot expect to have a really good evaluation with only ten C-4 canes, the limited number now available. On the other hand, there is the dilemma that one does not wish to build large numbers of additional copies if the present cane should seem hopeless, or if obvious improvements could be made based upon a limited evaluation.

An early-model cane, C-3, was shown relatively briefly in periods of a few hours to a few days to about 50 mobility experts in the New York, Boston, and Chicago areas. Beneficial suggestions received from this exposure were included during the design of the C-4 cane.

The C-4 cane was then presented for periods of weeks or months at a time to the staffs at Kines and Palo Alto VA Hospitals for preliminary trials by one mobility therapist functioning under a blindfold with supervision and instruction from a second mobility therapist. Because at that time the laser safety aspect seemed somewhat uncertain, the cane was used initially only on VA property.

With increasing confidence in all aspects of the cane, its use was gradually extended. Blind staff members were allowed to take the cane out on the adjoining streets for prolonged use in daily life. In addition, mobility therapists at other non-VA institutions were allowed to use the cane for periods of weeks or months with the goal of gaining greater insight into instructional methods and the use of the cane with a wider population. This extension included blind children at the Missouri School for the Blind, and civilian blind individuals in other settings, including Seeing Eye. Canes were lent to the Western Michigan University, California State College at Los Angeles, and Florida programs for teaching mobility instructors.

To combine the insights gathered by the various mobility instructors during the preliminary use under a variety of circumstances, a meeting was convened at Hines VA Hospital in September 1970 under the auspices of the Subcommittee on Sensory Aids, Committee on Prosthetics Research and Development, National Research Council[8]. There was general consensus that the forward-looking or middle beam was particularly valuable, although there was a somewhat variable opinion on the merits of the other two beams. There was some feeling that the upward-looking beam should be tilted forward to indicate targets about 2 ft. ahead of the tip of the cane when held at the "usual" 45-deg. angle (which mobility experts had suggested as the design condition) rather than directly over the tip of the cane as had been requested based on earlier experience. This return to the original design condition with reversal of the experience of earlier users illustrates the frustrations of both designers and evaluators of new devices in the cycles of repeated trials and redesigns which are needed in the development of both prosthetic and sensory aids.

Based upon the recommendations of the September 1970 meeting, small changes were made in the existing ten canes, and they were thoroughly checked over at the development laboratory. Five apiece were then distributed to Hines and Palo Alto VA hospitals, with the concept of supplying four veterans at each center and keeping one cane as a spare.

As noted earlier, a protocol for preliminary evaluation was developed by an NRC panel consisting of both engineers and experienced mobility therapists[1]. The plan calls for recruitment at each center of eligible veterans with better-than-average mobility skills, who will undergo intensive evaluation of ability with conventional long-cane techniques, training with the laser cane, and then evaluation on both obstacle courses and city routes of increasing traffic density during the month of August 1971. The performance of each subject will be recorded with motion-picture or video tape equipment. Each veteran will then take his cane home for continued routine use with follow-up by telephone contacts and visits by two mobility therapists. In a step relatively unusual in evaluation of prosthetic devices, each subject will later be asked to return to the use of a conventional long cane for a period of weeks, and to make a comparison.

It is hoped that the experience with the existing laser canes will contribute both numerical data and clinical impressions which will be useful in the development, prescription, and training programs for mobility devices in general. The protocol adopted for the laser cane probably can also be used with relatively minor modifications for the evaluation of other devices such as the Kay ultrasonic spectacles when used in conjunction with a conventional long cane.

One of the most important features of the evaluation is the development of prescription criteria. It is not enough to say that the cane is accepted or rejected by certain percentages of users. Rather it is necessary to discover the types of users for whom it is most appropriate. Long experience with prostheses and sensory aids has shown that there is no single panacea suitable for all users. Instead, different types of devices may be useful for different individuals or even for the same individuals under different circumstances. Thus one needs an armamentarium of devices from which selection can be made. Appropriate interdisciplinary clinic teams such as Visual Impairment Service Teams may then be used to help the patient in the proper prescription of devices, in training, and in checking out his performance with the new device.

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EXPERIENCE IN EVALUATION OF THE RUSSELL "PATHSOUNDER"

Howard Freiberger

The Veterans Administration has purchased four Lindsay Russell Pathsounders (LRP) and currently has two more on order. Some experience has been gained in the use of these mobility aids at each of the VA's three principal blind rehabilitation centers. Emerging from the work at both Hines, Ill., and West Haven, Conn., is the unforeseen finding that the LRP seems to be quite a useful aid for certain blinded persons confined to wheelchairs because of other infirmities. Excerpts from a case report illustrating this application follow:

> Once physically able to propel this wheelchair himself, work was begun with the "pathsounder" as the primary mobility tool. Using this aid both for environmental information as well as avoiding obstacles in his path, Mr. H made steady progress in achieving masterful "wheelchair" mobility. At the end of 34 sessions, Mr. H could safely and efficiently locate a series of objectives within a two-ward area.

Another possibly unexpected application of the LRP in VA settings involved blinded veterans who were unusually tall and those who had areas in the head or shoulder region which were particularly tender, vulnerable, or sensitive as the result of injury or surgery. Blinded persons in these categories were sometimes hesitant in stepping out as is required to achieve good mobility for fear of bumping their heads or sensitive tissues on high obstacles not detectable by the cane. Use of the LRP enabled them to detect such obstacles and gave them confidence as they forged ahead.

EVALUATION OF THE ULTRASONIC BINAURAL SENSORY AID FOR THE BLIND

Leslie Kay

THE DEVICE

DEVICE OBJECTIVES

The sensory aid has been designed to give a blind person a percept of his environment through his auditory senses at a level significantly higher than his unaided senses will allow. The hypothesis underlying the principle was based upon the apparently well known fact that after the visual senses the auditory senses were capable of handling the most information. It seemed only necessary to so code the information that it was processed optimally by these senses, and was in a form which readily enabled a person to perceive the environment from which the information was gathered.

This information is in the form of reflected signals from inhomogeneities in the environment, and when the illuminating source is light the total information is high and exceedingly complex. The eye has been evolved to handle this effectively and any alternative to vision must involve some information reducing element; at this stage of our technology, the reduction must be considerable. One very effective way of doing this is to increase the wavelength.

The binaural aid uses ultrasonic waves which cover a wavelength range of 2.5 - 5 mm. Light has a wavelength of the order of 10^{-4}mm so that the use of ultrasonics immediately introduces a reduction in information of the order of 50,000. This makes it more compatible with the auditory system. The auditory bandwidth which can be usefully used is approximately 5 KHz, but the bandwidth of the information carrier in the medium using ultrasound may be of the order of 50 KHz. Bandwidth compression is therefore necessary and is readily achieved using the Continuous Wave Frequency Modulation transmission. An input band of 50 KHz is effectively compressed to 5 KHz in the sensory aid, thus producing an overall reduction in information of 500,000 compared with vision.

The sawtooth modulation of the transmission frequency used in the aid is an ideal code for providing optimum matching to the ears. The cochlea may be looked upon as a spectrum analyzer which matches to the range coding of the binaural aid, and the whole system can be shown to form a "matched filter." This is the best which can be achieved in information transfer from the "medium" to the "display." (The display in the context of this paper is the auditory percept obtained by the observer.) The range cue of the device is thus simply described as echo pitch proportional to distance with 300 Hz corresponding to 1 foot. Built into this system is the facility to perceive quality (timbre) of the echo indicating the surface from which the echo was reflected.

The direction from which an echo is received is determined by the binaural effect produced by interaural amplitude difference. Whilst the ear may, for physical reasons, use interaural time difference and amplitude difference according to the nature of the sound, dichotic presentation of sounds is not so limited and IAD may be used throughout the audible frequency range to good effect. The ultrasonic sensors are so designed that, by suitably splaying them to look slightly left and right, the correct IAD for any individual may be closely approximated.

Thus, built into the binaural system are the means for determining direction, distance, and surface structure of objects in the environment. The effect on the auditory percept cannot be described; it must first be learned through a period of training. Head movement introduces subtleties which require a more detailed discussion than is suitable here.

ACUITY OF PERCEPTION

It must be quite obvious from the great reduction in information which has taken place that the acuity of perception cannot be likened to vision--not even with the greatest stretch of the imagination. Little can be said about this new concept in perception because it has been inadequately researched, but this, however, does not mean that it is inadequately understood for the purpose of evaluation. We all know what an orange tastes like, but we cannot describe this to anyone who has not yet had the pleasure. To the scientist who seeks after knowledge, this may seem to be a weak excuse, but the engineer is not so restricted by his code of practice--

to make things work for the benefit of mankind. I must emphasize this difference in philosophy because it has an important bearing on the form of the evaluation.

It can however be stated that the acuity of perception is little different from unaided hearing in determining direction, or in discriminating between two sounds. The accuracy in determining distance can be better than ± 10 percent and up to three objects at different ranges and directions within the field of view may be resolved by experienced users. This is the absolute limit under stationary conditions. Dynamic conditions seem to add another dimension which so far we have been unable to study adequately, but of course experience under dynamic conditions is now extensive.

Up-down acuity is poor and depends upon movement both of the head and the body.

SPECIFIC TASKS

Several teaching situations give an insight to the capability of the man/machine system. Complex tasks with arrangements of 1-2 dozen one-inch diameter poles have been learned by blind users which indicate the acuity of perception when mobile, and one can observe the smoothness of control of the motor system. Each person has to be taught to integrate the new percept with this control system and until this is reasonably well achieved mobility in a real life environment remains difficult and hesitant.

Typical tasks are:

1. Walk up to and grasp a 1-in. diameter pole from a distance of 12 feet.
2. Walk past a pole at a specified lateral distance, using rate of change of distance and direction to gauge relative positions.
3. Walk parallel to a row of poles at a specified distance.
4. Weave in slalom fashion between poles in a row or a circle.
5. Walk between two parallel rows of poles.
6. Walk through a complex pattern of poles using their juxtaposition for orientation.

7. Place a group of poles in a straight row.

8. Grasp one pole from a group of closely spaced poles.

All these tasks may be taught within one week of training.

OBJECT DISCRIMINATION AND IDENTIFICATION

The following objects are readily recognized in most situations:

Smooth pole
Window
Brick wall
Hedge
Bush
Tree
Parking meter
Parked car
Fencing
Railings
Isolated street sign
Doorway
Up-curb
Traffic islands
Pedestrian moving
Traffic lights
Mail box
Rising steps
Grass verge and smooth path
Overhead branches

This list is an example of objects blind people have frequently said they can recognize in both familiar and unfamiliar situations. The picture of the environment which they construct is less clear and we may never really know what an individual perceives when travelling. Much depends upon the attention at the time, the motivating force, or the complexity of the task being performed. Some merely seek a clear path until the situation demands a knowledge of the environment. We know of no means for monitoring what is perceived, only observing the performance and listening to verbal descriptions. These are always in visual terms but this does not mean that the perception is also in visual terms.

MOBILITY

This is a very complex task requiring skilled teaching in the first instance and an ability to use ambient cues effectively. The perception through the binaural aid has to be integrated with these cues effectively before it can be evaluated by a user or an observer.

Since the acuity of perception is severely limited, a dog guide or a long cane must be used in conjunction with the sensory aid for safety when traveling in an unknown environment. It is customary to refer to the long cane or the dog guide as the primary aid, but this thinking limits the potential of the device which must stand alone in its own right as a sensory aid. Because two aids are now being used simultaneously, there is a natural tendency to refer to the older aid as being primary; but since they play quite different roles, either may be the primary aid according to the situation and the source of attention of the user.

For the purpose of the evaluation, the device is used only in conjunction with the long cane or the dog guide, and this is how it will always be taught; but subsequent usage by a blind person may vary considerably, depending upon his needs and his environment.

The main value of the aid in a mobility situation is its ability to warn of objects in the travel path. Where a shoreline exists, this can be followed with ease and landmarks may be located at a distance aiding orientation and navigation. Of secondary importance is the ability to appreciate the environment, but this can give unexpected pleasure. It can neither be observed nor measured, but it may be a prime motivator and as such be very important. There is evidence to suggest this has already occurred.

USER POPULATION

Probably the major reason for having the current evaluation is to determine the user population. It is also going to be the most difficult to determine, and this is discussed under Evaluation. The aims, however, can be stated.

In devising the aid, no thought was given to a particular population other than those blind people who, through limited vision, have problems in going about their daily business. Some have tried to limit the population, usually without good reasons; but obviously the totally blind are in greatest need of an aid.

The criteria determining the range of people who should, hopefully, be able to use the binaural aid are:

1. Normal hearing in the frequency range 250 Hz to 6000 Hz. Special provision can be made for those with a high-frequency hearing loss and some hearing defects may not affect the perception greatly.
2. Physical fitness to travel on foot. There are, however, people highly motivated to travel even though they are multiply handicapped, e.g., amputees, and even those in a wheel chair, who may be aided significantly.

3. Motivation to be independent. There are people who, through lack of appreciation of what can be done, may not be well motivated, so motivation alone should not be a prime requirement. Some who were apparently not motivated or found travel by conventional methods too difficult have become highly motivated by a "vision" of what may be achieved with a new sophisticated aid. This should be neither underestimated nor deplored. It should be used judiciously to the advantage of the blind person.

4. So far as it is possible to determine, there is no physical reason why there should be a lower limit to the age of the user. The technology must be greatly improved and careful studies made of the possible side effects, but the possibility of young blind children growing up with the aid poses an irresistable challenge. The upper age limit must be indeterminate; so much depends upon the deterioration of an individual's physical and mental capabilities. The hearing may well be the most serious limitation to use by the older person. People in their 60's should not be automatically eliminated.

5. There is no evidence to indicate that intelligence is an important factor in developing a percept. The use to which this is put may well depend upon intelligence, however. Intelligence cannot be used as a criteria until there is a better definition of it. Tests to predict performance in a task are well known, and special tests may be developed in this field also.

6. Whilst those having total visual loss may receive priority in training, those with partial vision must be considered if they have mobility problems. Hence, the potential user population may be very great and it is predicted that it exceeds the population for the long cane or the dog guide. When statistics of the blind population range between 400,000 and 900,000 in the U.S.A., of whom half may be over 65 and only 10 per cent totally blind or have no more than light perception, the possible user population may be between 20,000 and 45,000 persons. Reaching these poses formidable problems.

What of the rest of the world where services for the blind are generally far behind those in the U.S.A., with of course few exceptions? So much is talked about the possible user population, but this is not important when, even with the best will in the world, it cannot be reached in the foreseeable future. More important is the training of teachers, and it is thought this will be more effective in determining policy in relation to a new device than the so-called user population.

THE EVALUATION

DEVICE STATUS

The device has been designed and manufactured at minimal cost because of the risks involved in attempting to introduce it to the blind. A separate paper, already circulated, describes the planning of the evaluation which was concurrent with the development. An aid of this type must be developed concurrently with an evaluation because it was quickly found that the display was more meaningful when used in real-life situations compared with simulated situations. This is because the information presented is very complex and both memory and *a priori* information play an important part in the perception. The dichotic presentation of simple simulated sounds in a laboratory did not produce a comparable effect although the response to these helped greatly in understanding the mechanisms involved.

Whilst the psychoacoustic tests were proceeding, the device was engineered to give optimal performance using the psychophysical data shown to be relevant.

At no time has it been shown possible to carry out psychoacoustic experiments which would have led to the present device. On the contrary the subjective response to the device signals dominated our approach, and we were forced to make the laboratory tests bear a strong relation to these. This is due to both technological and psychophysical limitations related to gathering the information from the environment and presenting it to the auditory system.

Even at this advanced stage in the development, it is difficult to see how the current program could have evolved in any other way. The device then is as well advanced as was possible within the constraints of the funding made available, and it is sufficiently developed for the risk involved in using it with 200 or more blind people to be small. It was thought unlikely to fail to be acceptable to both blind people and their teachers. This was implicit in my requesting a large evaluation.

The device is not, however, well developed. A great deal of work is still required before we could say no further improvement is possible.

There is no reason, however, why blind people should have to wait until this is done. Relatively minor modifications are necessary to insure reliability in service with adequate performance.

TEACHING

Two courses of instruction for teachers were held in New Zealand and Australia prior to the Canterbury Team coming to the U.S.A. in March of this year (1971). Two further courses have been held at Boston College and Michigan Rehabilitation Center under the auspices of the University of Western Michigan. A total of 29 Orientation and Mobility instructors have now been trained.

These courses included learning to use the aid under blindfold with the long cane for a period of up to 40 hours. Most of the teachers reached the advanced business area and demonstrated skill in using the aid/cane combination.

The training courses have constituted a form of evaluation since few instructors would have devoted much time subsequently to training blind people if they were not satisfied that at least the aid had something of value to offer to the blind person. At the time of writing approximately fifty blind persons have been trained and two evaluation reports have been written. One is an individual evaluation by a very competent blind person. The other is a report on the training of twelve guide-dog users and three long-cane users.

At this point in time, we cannot prejudge the outcome of the evaluation, but it is proceeding much as expected, a little behind schedule.

METHOD OF EVALUATION

The proposed evaluation discussed in the circulated paper (Appendix C) was considered in detail during the first course at Boston College in April-May 1971. Three projects were given to groups of instructors, some of whom were the most experienced Orientation and Mobility specialists currently in practice. The first project of one week's duration was to determine how to measure mobility using the long cane alone. The second project was to determine how to measure mobility using both the long cane and the sensory aid. The third project was to test some of the measures devised during the first two projects.

The third project was abandoned after it became evident that the instructors felt that mobility is too complex to measure at present, and those simple measures which have been used in the past and were proposed in the course notes were too inadequate to be of real value. Clearly, without the full cooperation of Orientation and Mobility specialists, it was pointless to try and gather objective data of the kind proposed. It was agreed, however, that Score Sheet I (Appendix C.a, p. 16) would be used.

It was readily agreed that experienced observation of mobility performance would give a more reliable assessment of the capability of the man/machine system. Using nearly thirty instructors, we should get a well-balanced opinion. It was also agreed that where possible film would help in the assessment.

EXPERIENCE TO DATE

The decisions have proved to be correct. It would have been quite impossible and useless to attempt to take objective measures during the training of blind people at this early stage. The instructors have found teaching the sensory aid both challenging and time-consuming requiring high concentration on their part. They could not have taken records.

In addition, almost all the blind people chosen for training have already had long-cane training so the original plan became irrelevant. A new one would have to be devised. Now only those people who have had long-cane training will be used in the evaluation. There are two reasons for this. At the present stage, the instructors feel that in the case of novices the sensory aid will conflict with the teaching of the long-cane techniques. Also, the time taken to teach a novice both the long cane and the sensory aid will be of the order of sixteen weeks. Using experienced travellers, only four weeks is needed, and the evaluation will therefore not take so long to complete. It can also be said that experienced travellers are likely to be more critical of a new device since they already know what is possible without it.

Technical and administrative problems in all sectors have slowed down the program temporarily, but these have now been reduced considerably, and by November the program should be in full swing again.

POSSIBLE BENEFITS FROM THE SENSORY AID

It is premature to say much at this stage, but some features about the use have now been well established.

The aid does reduce travel stress and the auditory signals do not interfere with the use of ambient cues. Mobility is improved--as observed by the instructors. The sounds are not unpleasant and are often thought to be pleasant and reassuring. The device is cosmetically acceptable and easy to use. It takes about four weeks to train a dog-guide or long-cane user to feel comfortable in an advanced business area. Prolonged learning takes place and so far no one has discarded the device even though the period of use is up to two years for the first person trained.

The questions we have not so far answered are numerous and this evaluation will only answer a few more. We are only just beginning to appreciate the complexity of this new form of perception and the effect this may have on mobility. The teachers seem to be challenged by its potential.

DEARING LIGHT-SENSING TYPHLOCANE - MODEL LST-3
RECOMMENDATIONS FOR EVALUATION BY THE VETERANS ADMINISTRATION

Eugene F. Murphy and L. M. Dearing

The Dearing Light-Sensing Typhlocane Model LST-3 was originally designed to enable the mobile blind to find and to follow the white or yellow painted pedestrian-crosswalk lines used by many cities to protect pedestrians at street crossings. Our blind friends told us that standard long-cane travel techniques were insufficient and created hazards during such crossings.

The Model LST-3 is a passive detection device utilizing the reflection of ambient light from the sun and sky during daytime hours, from street lighting during nighttime hours, and from artificial light inside buildings and homes. It senses the reflective light patterns from the terrain a few inches ahead of its long-cane tip and provides the mobile traveler with sound cues with frequency varying directly with the amount of light reflected from the surface being scanned. It can be made an active detector for dark operation by incorporating a small artificial-light source alongside the photocells inside the cane.

The Model LST-3 is ruggedly constructed and configured to imitate the long cane (Typhlocane) in feel, conductivity, balance, and operation. It is intended to be used by the blind traveler first as a long cane, next as a light-sensing probe.

EVALUATION

We recommend it be evaluated for the value of its added useful information to the blind when traveling with the standard long-cane travel and mobility techniques with their protective touch, swing, and slide movements. Under no travel circumstances should it be used without these long-cane protective scanning movements.

The light-sensing ability of the Dearing Light-Sensing Typhlocane --LST-3 gives added information to aid blind mobility in situations where only painted stripes or light patterns exist, such as painted pedestrian-crosswalk lines. The blind who have tried the LST-3 find it especially useful for right-angle crossing in finding and following the pedestrian crosswalk for the second leg of the crossing. It can also be used in closed or conditioned environment--with painted reflective guidelines in or out of Veterans Hospital--a judicial combination of color and brightness, or broken line codes, would allow multiple stripes leading to selected areas. How about using this system for physical activity or sports--shuffle board, hopscotch, etc.? These situations are very difficult to find with the standard long-cane travel techniqûes. It is our recommendation that the initial evaluation be centered primarily around pedestrian-crosswalk and controlled-environment stripe detection.

Due to the fact that the LST-3's light-sensing probe detector provides aural cues for small differences (10% to 25%) in light reflected from any surface or object (pavement, ground, floor or standing objects), a supplemental evaluation of these factors is also needed. Changes in ambient light from shadows cast by objects obstructing the sun (shadows average a 75% reduction in light) give a reduction in frequency of the sounds. At this lower frequency the cane still retains its ability to sense differences in terrain reflection such as stripes, cracks, path borders, curbs, etc. The cues in shadows are higher pitch for reflective and still lower pitch for darker surfaces. This can be a nuisance (i.e., confusing) but also, with training, does provide the blind with extra useful information. Hence it is important to evaluate the LST-3's ability to complement its built-in long-cane touch-and-feel technique potential while still giving the mobile blind additional information about their surroundings--shadows do importantly resemble the real object. Evaluators skilled in long-cane mobility training should thoroughly explore all possibilities for additional training of the more intelligent blind travellers to use this added information about their environment and thus be able to travel more intelligently, more easily, and more safely.

In summary, it is desirable that the evaluation of the Light Sensitive Typhlocane Model LST-3 should determine its ability to:

1. Protect and guide the blind traveler at pedestrian crosswalks and in controlled environments where painted stripes can be used.

2. Sense and inform trained blind travelers more thoroughly about their environment.

3. Check out the LST-3 mechanical and physical characteristics.

4. Examine the adequacy of the human factors inherent in this design and make recommendations for changes to make it more useful.

5. Project the type of superior training needed to convert the often-noted liabilities of confusing signals, e.g., shadows, patched pavement, etc., into real assets of extra information available to the blind traveler when the LST-3 is used with standard long-cane traveling techniques.

EVALUATION SPECIFICS

During the three years of in-house research and development leading to the current Model LST-3 of the Dearing Light-Sensing Typhlocane, considerable practical testing has been done by mobility trainers, blind travelers, and LMDA company personnel. The wide range of light sensitivity, plus the ability to probe a narrow ground angle, lead to many interesting possibilities extending beyond the original concepts which permitted accurate crossing of streets by following painted crosswalk stripes or using painted guidelines in special situations found in public buildings and some sports.

Typical aural cues found by these testers while using standard long-cane traveling techniques include: sensing a pencil, or other small objects; following small crack lines parallel to the travel direction between cement squares on a long sidewalk--thus encouraging straight line travel; counting sidewalk squares perpendicular to travel direction; intelligent use of shadow information, etc., to determine location within block.

Table 1 lists some of these characteristics that seem worth evaluating and suggests a rating system.

MECHANICAL AND PHYSICAL

The Dearing Light-Sensing Typhlocane Model LST-3 should be evaluated vs. the VA Specifications for the Long Cane (Typhlocane) February 1965 for general ruggedness and design.

Table 1.

EVALUATION OF LST-3 LIGHT-SENSITIVE TYPHLOCANE

SENSING CHARACTERISTIC	Rating of ability to sense after suitable LST training			Added value of LST-3 sensing for mobile blind when used with prescribed long-cane travel technique	Other
	Always	Percent of Incidents	Never		
1. Painted stripes at crosswalks					
2. Guide stripes for hospital & games--parking lot stripes					
3. 1 & 2 in shadows					
4. Curb - perpendicular to travel from sidewalk level					
5. Same--curb--parallel to travel direction					
6. Sidewalk squares & cracks					
7. Path borders--brick or ground					
8. Path borders--grass or foliage					
9. Snow & ice conditions					
10. Shadows--use to find points of compass					
11. Shadows as indication of building or obstacle					
12. Shadows--traveling across requires 2 sound levels on sensing other light patterns					
13. Other					

Though a closable "Crook" is available as an accessory, a looped rawhide thong attached to the speaker cone is standard with the Model LST-3 cane. It is recommended that trial users put this thong around their wrist to avoid hard drops of the handle portion onto pavements or other hard surfaces. When the speaker cone hits the pavement first, our destruct tests on the LST cane showed that such hard vertical shocks can shake loose the magnet in the speaker. The earphone still works.

With this exception we have found the cane survives vertical shocks and other shocks found in normal hard use. Aluminum tubing can be used instead of fibreglass tubing if it proves desirable. Rather than destroy a complete cane, selected parts such as a fibreglass lower cane blank, etc., can be furnished to the Veterans Administration for testing.

Conductivity of the LST-3 cane is somewhat different from the long cane, probably due to the fibreglass portion. Evaluation should determine whether the LST-3 conductivity is useful even though different than the aluminum cane.

HUMAN FACTORS

The Dearing Light-Sensing Typhlocane Model LST-3 was engineered to come as close to the VA long cane as possible, considering the necessary inclusion of sensing probes, electronic circuits, control knobs, batteries, speakers, etc. There are some specific questions on which the fine experience of VA mobility experts would be helpful, particularly as we develop other types of long canes with light-sensing or distance-measuring capabilities.

1. Speaker and earphone

    1.1 - Is speaker useful for training?
    1.2 - Is speaker needed for use after training?
    1.3 - Can we use a lower-volume, lighter-weight speaker?
    1.4 - Can we eliminate the speaker and use only the earphone?
    1.5 - Is a tactile cue preferred?

2. Sound - It is now a narrow 5% duty cycle pulse or spike. Tone and frequency range can be improved at cost of greater current usage and shorter life between charging. Is this desirable?
3. Control Knobs - Can the blind feel present engraved pointer mark?
4. Crook - At small cost a two-position--open and closed--crook can be attached to the speaker cone. Is this desirable?
5. Shaft - Can use aluminum 2024 if desired (like new VA cane) instead of fibreglass shaft.
6. Two-Piece Cane - A two-piece prototype was made using a screw-type connector. The added weight was (+3/4 oz.) so the LST-3 was made in one piece. Is the two-piece feature worth the added weight?

TRAINING OF THE MOBILE BLIND IN LONG-CANE AND SENSING TRAVEL TECHNIQUES

Earlier models of the Dearing Light-Sensing Typhlocane were given preliminary evaluation by mobility trainers. Usually their initial reaction has been rather negative, as is to be expected when changes are introduced to the long cane. On the other hand, the blind people who have had it in their hands and tried it out want it. One elderly woman with prior long-cane travel training stepped out on the sidewalk with a LST-3, found the cracks between 3-foot squares parallel to the building line, strode in a straight line using long-cane swing-and-touch movements but steering with the aural cue as the tip swung over the crack, following it accurately. She found the curb by touch (she had an early aural-cue curb warning), then found some very broken crosswalk stripes by LST-3 aural cues, and followed the stripes straight across the street safely back and forth. We again cautioned her to always use the long-cane protective movements and touch contact.

It would be of great value to us in future planning if the experienced long-cane experts of the Veterans Administration could provide guidelines that will project the type of training needed, not only for the simple detection of painted strips at crossing or in controlled environments, but also design the format for the superior training needed to convert the often-noted liabilities of confusing signals, e.g., shadows, patched pavement, etc., into real assets of extra information available to the blind traveler, always assuming that sensing canes such as the LST-3 will be used with standard long-cane traveling techniques.

EVALUATION OF MOBILITY AIDS

J. D. Armstrong

During the past decade, something like a dozen new mobility aids have appeared in the United States and the United Kingdom. Most of these aids are electronic devices and, with the exception of only one of them, they are all still at either the prototype or evaluation stage.

Since none of these devices is, or in fact claims to be, the final solution to the mobility problems of the visually handicapped, there is an obvious need to establish some technique for their evaluation.

There are three major reasons why evaluation is necessary:

1. To make definitive statements about the usefulness of individual devices as aids to mobility. We need to know what can and cannot be expected of a particular device in the mobility situation.
2. To isolate the reasons for the failure of a specific aid to provide necessary mobility information. By isolating the shortcomings of a specific device we will be able to ensure that such failures are not repeated in future developments.
3. To provide both the agencies for the visually handicapped and the mobility instructors with adequate information about the performance of the various aids available so that the most suitable aid and accompanying training to the client might be prescribed.

At the present time, most of the information which is available about devices is the result of evaluations carried out by the inventors or developers of those devices along with the occasional reports from a few users.

There are very good reasons why this type of evaluation does not normally provide information required under the three headings above. The inventor usually adopts evaluation procedures which are intended to compare the performance of the device with its original specification. This type of evaluation tends to be an ongoing process which accompanies the development of the device.

Even when an inventor considers his device in mobility terms, the evaluation is still very much colored by the nature of the aid itself.

Thus, it is argued that there is a great need for the development of an objective evaluation technique which is capable of assessing the performance of a device purely as an aid to mobility.

One of the first attempts at the development of such a technique was made by Leonard and Wycherley in 1967[2]. At that time Leonard and Wycherley advanced a number of "specifiable criteria" for blind travel. These criteria referred to both broad and specific activities normally observable during blind travel. An attempt was made to analyze the performance of a traveler in terms of these criteria in an experiment carried out in Shrewsbury with children from the Royal Normal College. In spite of the practical difficulties of scoring performance whilst following hard on the heels of the blind traveler and the fact that the measures relating to the chosen criteria were, for the most part, not sufficiently sensitive, there did emerge a reasonably clear profile of the activity of the traveler over the route. Leonard and Wycherley admitted that ". . . this was by no means a perfect job (but) we would submit that this represents a more objective manner of assessing travel skill than any reported so far."

Since 1967, work on the development of more powerful performance measures has been intensified at the Blind Mobility Research Unit. The availability of portable and inexpensive video recordings equipment has almost totally reduced the practical problems of scoring specific events on the route and a permanent record in this form can allow detailed inspection of such events which, in a real time setting, would have been impossible.

The present evaluation technique was principally developed in order to assess the usefulness of the head-mounted version of the Sonic Aid[1]. It has obviously been strongly influenced by the Leonard and Wycherley study but it is much more specific in its measure relating to mobility criteria. However, like the 1967 study, its measures are independent of the device or training being evaluated.

Three major dimensions of mobility performance have been specified. They are (1) safety, (2) efficiency, and (3) psychological cost. These will now be considered in more detail.

1. Safety. The blind traveler, with or without an aid, must be protected from physical damage. Whilst on the sidewalk, he must be prepared to encounter obstacles originating at ground level at any position on the sidewalk and obstacles which overhang or protrude into the sidewalk space. He must also avoid stepping into the roadway by accident. When crossing roads, he should at least be as safe from damage from motor vehicles as sighted pedestrians.

2. Efficiency. If he so wishes, the blind traveler should be able to cover the distance between two locations by the shortest possible route and in the shortest possible time.

   To achieve this end, the traveler must be aware of both his position and orientation with respect to the route as a whole and his position and orientation with respect to his immediate environment.

3. Psychological cost. The traveler should not be caused unnecessary stress as the result of using a particular mobility aid or technique. Ideally such an aid or technique should reduce the level of psychological stress observable in blind pedestrians[3].

Specific measures have been evolved so that the blind pedestrian's performance can be related to the three dimensions. The process involves scoring mobility performance in 16 categories, each of which relates directly or indirectly to the efficiency and safety of progress. Two other measures, so far not well developed, are intended to indicate the level of psychological stress experienced by the traveler.

The actual scoring procedure is lengthy and will be published in due course.

The evaluation technique should be capable of providing an overall measure of performance in a number of experimental situations. It should be useful in the base-line evaluation of a specific device (i.e., performance with the device versus performance with no device), in the direct comparison of different aids, and in the comparison of different training programs for individual aids. Alternatively, it could provide an objective measure of performance of the traveler himself.

LITERATURE CITED

1. Armstrong, J. D., A head-mounted version of the sonic aid, New Beacon, LIV, No. 641, September 1970.
2. Leonard, J. A., and R. J. Wycherley, Towards the measurement of performance of travel skills, Proc. Conf. for Mobility Trainers and Technologists, Massachusetts Institute of Technology, Faculty Club, 1967.
3. Peake, P., and J. A. Leonard, The use of heart rate as an index of stress in blind pedestrians, Ergonomics, 14:2:189-204, 1971.

GENERAL DISCUSSION AND RECOMMENDATIONS

Unfortunately, very little time was left for a general discussion. However, each presentation had been followed by some discussion.

In the time available only one recommendation was set forth. Upon the suggestion of Dr. Murphy and Mr. Mauch, it was recommended that a panel be established to guide the Veterans Administration in making decisions in reference to the Visotoner.

January 1972

APPENDIX A

AGENDA

CONFERENCE ON EVALUATION OF SENSORY AIDS FOR THE VISUALLY HANDICAPPED

SUBCOMMITTEE ON SENSORY AIDS
COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
NATIONAL ACADEMY OF SCIENCES--NATIONAL RESEARCH COUNCIL

National Academy of Sciences
Lecture Room

November 11-12, 1971

9:00 a.m., Thursday, November 11

I. ORIENTATION	Newman Guttman, Chairman
II. THE ROLE OF EVALUATION IN THE PROSTHETICS AND ORTHOTICS PROGRAM	Colin A. McLaurin A. Bennett Wilson, Jr.
III. "A SUCCESS STORY"	C. Warren Bledsoe
IV. EXPERIENCE IN EVALUATION OF SENSORY AIDS	
A. Reading Machines	
1. Optophone	Eugene F. Murphy
2. Visotoner	Howard Freiberger
3. Optacon	James C. Bliss
4. Cognodictor	Eugene F. Murphy Hans A. Mauch
B. Mobility Aids	
1. Signal Corps - RCA Units	Eugene F. Murphy
2. Bionic Cane	Howard Freiberger Patrick W. Nye
3. Russell Device	Eugene F. Murphy Lindsay Russell
4. Kay Devices	Leslie Kay
V. PLANS FOR EVALUATION OF DEVICES READY OR NEARLY READY FOR EVALUATION	
A. Reading Machines	
1. Optacon	Office of Education
2. Visotoner - Visotactor	Veterans Administration
3. Cognodictor	Veterans Administration
4. Others	

9:00 a.m. Friday, November 12

B. Closed-Circuit Television Reading Aids	
Status Report	Howard Freiberger
C. Mobility Aids	
1. Bionic Cane	Veterans Administration
2. Russell Device	Veterans Administration
3. Kay Devices	Leslie Kay
4. Dearing Cane	Veterans Administration
5. Others	
D. Braille Developments	
1. Braille Tape Recorder (Argonne Laboratories)	Office of Education
2. Others	

VI. PROPOSALS FOR FURTHER EVALUATION

- A. General Discussion
- B. Recommendations

PARTICIPANTS

CONFERENCE ON EVALUATION OF SENSORY AIDS FOR THE VISUALLY HANDICAPPED

SUBCOMMITTEE ON SENSORY AIDS
COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
Washington, D.C. November 11-12, 1971

Newman Guttman, Chairman, Bell Telephone Laboratories, Naperville, Ill.

John Aellen, National Bureau of Standards, Washington, D.C.
John D. Armstrong, Blind Mobility Research Unit, University of Nottingham, England
Michael P. Beddoes, Department of Electrical Engineering, The University of British Columbia, Vancouver, B.C.
Nancy Bell, Orientation and Mobility Specialist, Boston College, Chestnut Hill, Mass.
J. Malvern Benjamin, Jr., Bionic Instruments, Inc., Bala Cynwyd, Pa.
C. Warren Bledsoe, Consultant on Blindness, RSA-SRS, Department of Health, Education, and Welfare, Washington, D.C.
James C. Bliss, Bioinformation Systems Group, Stanford Research Institute, Menlo Park, Calif.
Frank S. Cooper, Haskins Laboratory, Inc., New Haven, Conn.
LeRoy M. Dearing, L. M. Dearing Associates, Inc., Studio City, Calif.
Howard Freiberger, Research and Development Division, PSAS, Veterans Administration, New York, N.Y.
Martin J. Kaufman, Division of Research, U.S. Office of Education, Washington, D.C.
Leslie Kay, Dean of Engineering, University of Canterbury, New Zealand
William Keith, Hearing Specialist, Boston College, Chestnut Hill, Mass.
Thomas E. Knox, Restoration and Sensory Aids Division, PSAS, Veterans Administration, Washington, D.C.
Harvey Lauer, Electronic Reading Specialist, Central Rehabilitation Section for Visually Impaired and Blinded Veterans, VA Hospital, Hines, Ill.
John Linvill, Bioinformation Systems Group, Stanford Research Institute, Menlo Park, Calif.
John Lyman, Biotechnology Laboratory, University of California, Los Angeles, Calif.
Robert W. Mann, Massachusetts Institute of Technology, Cambridge, Mass.
William B. Marks, The Johns Hopkins University, Baltimore, Md.
Hans A. Mauch, Mauch Laboratories, Inc., Dayton, Ohio
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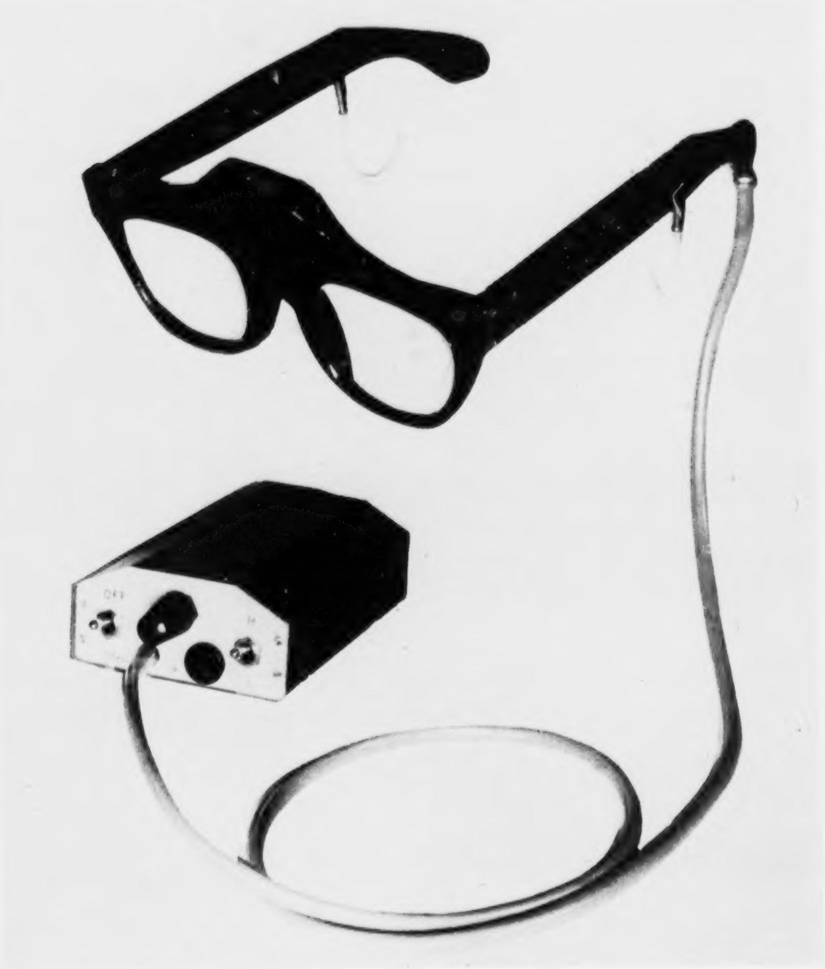
Russell C. Williams, Blind Rehabilitation, Veterans Administration, Washington, D.C.
A. Bennett Wilson, Jr., Executive Director, Committee on Prosthetics Research and Development, National Research Council, Washington, D.C.

EVALUATION
OF
BINAURAL SENSORY AID FOR THE BLIND

(taken from the lesson notes for the instructors training course)

Professor L. Kay FRSNZ[*]



Ultrasonic Binaural Sensory Aid for the Blind

[*] Dean of Engineering
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Probably the most useful dissertation on the evaluation of sensory aids came from John Dupress[2]. In his final analysis there appeared to be only two simple but relevant questions concerning the ultimate worth of a device:

1. Does it facilitate better performance without excessive training, fatigue, stress or injury to the traveller or pedestrian?

2. Does a blind person use a device voluntarily for an extended period after the evaluation is concluded?

These two questions seem basic to any evaluation, but perhaps not included in (1) is the question, "Does the device facilitate mobility in those who could not be mobile by existing means?"

The current evaluation program is designed to answer these questions, but they may not be answered to the satisfaction of everyone. There are essentially five groups of people concerned:

1. The blind
2. The administrators of agencies for the blind
3. The teachers of the blind
4. The behavioral scientist
5. The device designer

To meet the requirements of each group an extensive program of evaluation is necessary and is the reason for the size of the present undertaking. Even so, it may be too limited to do justice to the needs of each section of the interested community.

THE BASIC REASONS FOR EVALUATION

That a device should be evaluated is, today, a universally accepted fact; but few are specific about why. Perhaps it is because each person or group simply wants to be "convinced," but is unable to say what would be convincing. One would expect a major reason for evaluating a device to be the establishment of facts on which to base decisions regarding funds for the purchase and supply to blind people of the device. When agencies are asked to indicate what facts they need the reply is not very helpful. This is understandable because the facts must be related to the specification of the device which very often is not available. The specification must include a statement of what can be achieved, and prior to an evaluation it is unlikely that this information is available, and so we start to chase our tails.

This frustrating circle has been broken for the binaural sensory aid through concurrent planning of the development and evaluation. We are now in a position where we can consider the possibility of meeting the requirements of each interested group who has very different thoughts about evaluation.

The Blind People

It is natural that each blind person should want to know what there is in the device for him. The only way to find out is to try it. This is personal evaluation and the answer comes quickly in one of three forms: (a) "No good"; (b) "Interesting and should help those people who are not so capable as I"; (c) "I like it; it helps." For a device to be successfully effective the latter response should be obtained from the majority of blind people not only after short exposure, but also after a considerable period of time and experience.

We have immediately created a problem. Are we to include in the term "blind person" those with some vision--and if so, how much? When we say "the majority of blind people" are we to include the very young and the very old, and what is a "considerable period of time?"

These terms need definition.

The Administrator

When committing funds their use in one area has to be weighed carefully against the benefits which could have been obtained by their use in another area. Cost-effectiveness is obviously a major factor but probably the most difficult to measure. Effectiveness is the complex factor we would all like to be able to measure; it is even difficult to define. In the case of mobility we are concerned with:

1. The psychological effect mobility has on a person
2. The degree of proficiency reached with the aid compared with that without

3. The increased value of the individual to the community
4. The increased earning potential of the individual

Perhaps 1. is the most important yet it is the most difficult to assess. When asked "Is it worth it?" what information is needed to say "yes?" Statistical data will help to determine the long-term funding required since this is related to a large number of clients but predictors based on personality inventories are also needed to assess the probable value to the individual. In reality of course most administrators will make their judgments based upon experience gained from a trial run within their own establishment whatever may be the data gathered from large-scale evaluations, simply because data is unemotional and impersonal. Administrators are however influenced very heavily by the judgments and decisions of their counterparts elsewhere. So perhaps the individual decisions arising from the several pilot runs inherent in the present evaluation will be of paramount importance in the evaluation.

The Teacher

Administrators are going to be influenced greatly by the reports from the Orientation and Mobility instructor who is responsible for the teaching of blind people. Unless he believes in what he is teaching the end result of his efforts are likely to be "inferior" and the decisions based upon his reports will be suspect. It is very important therefore that each instructor be fully familiar with the device, the method of training, and what can be achieved through its use. This in no way prejudges the evaluation itself; the piano, for example, is known to be a fine instrument, but very few can play it well.

The mobility instructor can therefore be expected to play a major part in the evaluation of a mobility device, and so he must be trained to use the device and teach its use. This involves a course for the instructors and they themselves require a teacher, or teachers, who are adequately knowledgeable in all aspects of the device and its use. Only the research and development team can fill this role initially and their ability to do this will be reflected in the end results.

Evaluation of a device of this kind is therefore dependent upon the ability of a number of people--not only the potential of the device.

The opinion of instructors of the blind will carry considerable weight; in consequence it is important that this opinion be not confined to two or three who could be biased. A sufficient number must be involved so that a majority opinion has meaning. From the 29 instructors who will be involved in the current program answers to a simple but well-designed questionnaire should produce a meaningful consensus of opinion. This, together with the opinion of the blind person, should help the administrator in his decisions.

The Behavioral Scientist

The aim of the behavioral scientist in the present context is to measure performance in executing a skill, and from this design better methods of training. When a device is involved, his task is to determine if it helps significantly in the execution of the skill and suggest ways in which to perform a skill. An optimum device should be provided if one is to be used.

Many realize of course that devices germinate from ideas which may not lead to the optimum form. In the absence of any other relevant information however they have to be used. There is of course a body of opinion which believes that an optimum device can only be designed through a basic study of the problem and unless it can be shown that an existing (albeit new) device is performing optimally, the call for a basic study will persist.

During this evaluation an attempt should be made to determine how near the design of the device is to optimum. To do so however we need a definition of the task and a specification for optimum performance. We can then proceed to measure how well this is achieved.

Recent attempts to measure mobility performance[1,3,5] have pointed the way towards a meaningful measurement of mobility skill but do not specify adequately what the skill should be. This is left to opinion. We do not therefore know how far we are from optimum performance when observing a traveller. The use of sighted mobility as the goal has been mentioned, and it would seem that such a goal would be acceptable to all. The introduction of sighted mobility as the upper limit of a rating scale at this present time may seem highly presumptuous and it has so far been avoided; but we do now appear to have reached the stage where we can reasonably use this high rating even if we do not actually approach it.

Since this criterion has never been used before, we are likely to encounter considerable problems in using it, but we do have an opportunity to work these out and perhaps play a part in the further development of new type aids to mobility. Some agreement is needed on where long-cane and dog-guide travel comes on this rating scale when sighted travel is say 100.

The Device Designer (Engineer)

The aid is designed to provide spatial information by audible means, and we need to know just how well this is achieved. Simulated experiments in the laboratory indicate certain limitations, but real life experiences are known to provide information which enhances that from the aid. We cannot at present assess the value of _a priori_ information. Until we can determine the limitations of the new form of perception we will not know what improvements are desirable in the device itself, nor will we be able to consider the role of other sensory aids. The evaluation should be such that these measurements can be carried out using the blind subjects, but it must be apparent that only the designers can do this, assisted of course by suitably qualified people who can advise on behavioral experiments and make experimental measurements in this field.

GENERAL COMMENTS

It has been shown that whilst the behavioral scientist and the engineer can provide information which will be of interest and value to the administrator, the really important person is the Mobility instructor supported by the blind person himself. Both must be in favor of using the aid before it can be supplied as an acceptable means to better mobility.

The program has been so designed.

THE DEVELOPMENT AND EVALUATION PLAN

It is not possible to isolate the evaluation process from the development of the binaural sensory aid although it is customary for this to be done in general. Evaluation usually relates to a final product, but in this case many changes are envisaged in the future once it is shown that the basic principle of the device is well-founded. In fact the evaluation has been proceeding for some time past following a plan of development designed in 1966.

The Sonic Torch, which was in fact an early off-shoot of the present device, was developed semi-commercially with the support of agencies for the blind who planned their own evaluation. Its parameters were not studied as they should have been, largely through lack of funds and inadequate facilities, and the method of usage was not explained. It is only recent that objective information about its use as a mobility aid has become available[5] and even this is restricted in value. Quite clearly the development and evaluation of the device left a lot to be desired. This became very obvious at the Sensory Aids Conference in 1966[4].

The Binaural Sensor was then in a portable experimental form and a study of its design parameters had begun. After the conference, it was evident that if the Binaural Sensor was to be made into a useful and acceptable aid for the blind, significant funding would be necessary and a careful plan of development and evaluation put into operation. The National Research Development Corporation allocated the funds in 1967 and a team of engineers and technicians was formed at the University of Canterbury.

There were two objectives:

1. Study the auditory output of the device to determine the relative significance of the direction cues, and determine the optimum arrangement of the transducers. Other forms of auditory display were to be considered to assess their relative merit.

2. Develop the electronics and transducers to obtain the optimum technical design in terms of performance, cost, size and reproducibility.

When these two objectives were sufficiently advanced psychologists were to have been recruited onto the team with the object of studying the psychoacoustics and training blind people to use the long cane in conjunction with the sensor. It was also planned to compare this combination of aids with the Sonic Torch.

As the device developed it became clear that the study of the auditory output, which was an engineering task, and the psychoacoustics could not be separated, both were part of the development process. The design was gradually changed to improve the performance, and through this process the original concept became more realizable.

This can be simply stated. Through the radiation of ultrasonic waves objects within a cone of approximately 60 degrees and up to a distance of approximately 20 feet produce at the two outputs of the device binaural information indicating:

1. the distance, by the pitch of the sound, and
2. the direction, perceived naturally through the binaural process.

All other features of the device are derived from this basic concept.

By April 1968 the device had reached a stage of development when the training of blind people could be considered. It had by then become evident that an Orientation and Mobility instructor would be more likely to succeed in training blind people than would a psychologist who had no knowledge of blindness or mobility. By the end of 1968 an Orientation and Mobility specialist had joined the team.

The engineers had by then established that the device produced the requisite information and through this one could perceive space by the auditory process. They had in fact evaluated it as a basic engineering system to their satisfaction. What had to be done next was teach others to perceive in the same way and use this percept to aid mobility. The gap between engineers and mobility specialists had to be bridged before much progress could be made.

By August 1969 (ten years after the original concept was formulated) four blindfolded sighted subjects were taught to travel with the assistance of the long cane and the binaural sensor, and the first cosmetically acceptable device was made, using a design of transducer and electronics which were thought to be reproducible.

Plans had by then been laid for the training of 20 to 30 blind people on the basis of the results obtained with the four sighted subjects. Funds for this were provided by the New Zealand Foundation for the Blind and The Royal Guide Dogs Association in Australia. Thirty aids were produced as a manufacturing exercise. A second Orientation and Mobility specialist was recruited onto the team.

The aims of the second stage of what was now becoming an evaluation were simply:

1. Devise a method for training blind people to travel with both the long cane and the sensory aid or the guide dog and the sensory aid.
2. Gain experience from observation of mobility with the sensory aid.
3. Assess the technical reliability of the device and modify the design to eliminate as many defects as possible ready for a major evaluation.

At this point in time the current evaluation program was planned and funding sought. This has now increased the number of mobility specialists involved in the program to 29 and the number of blind people will eventually rise to 250 by the end of 1972.

Even if we were unable to satisfy the requirements of our scientific and engineering colleagues, we will, through the reports of the instructors and the blind subjects, provide the information needed by the administrators of the agencies and the evaluation, by their standards, should be successful.

The co-operation of the instructors however is needed if we are to obtain the scientific and engineering information we need for further development.

OBJECTIVE MEASURES

General Discussion

Even though the instructor will inevitably express an opinion about the sensory aid based upon observation during the training of his pupils, he should be able to justify this. There should also be some uniformity of views between instructors.

If, for example, one instructor teaches mainly older immobile adventitiously blind people, and another has the task of training congenitally blind teenagers, one would not expect the conclusions drawn by these two instructors to be the same. The basis for the conclusions should however be similar because the task of the blind person is the same whatever the age or cause of blindness.

At this stage we can perhaps hazard a guess about the possible conclusions drawn from these two groups of people--so as to highlight the evaluation problem. It is possible that the older group will be able to reach a higher level of performance with the sensory aid/cane combination than with the long cane alone. We would not expect this to be more than an ability to travel in quiet business areas, and visit friends, social centres, etc., without great stress. The teenager on the other hand is more likely to become outgoing and adventurous exploring the environment in a way that would not be possible without the sensor. They should surpass the skill of the older person at an early stage in their training and go significantly beyond the level normally reached using the cane alone.

The opinion of the instructor training older people would depend very much upon his knowledge of what could be achieved with the cane and what he expects to be possible with the additional aid of the sensor. He will most probably be influenced by what he thinks the cost benefit should be for this group of people. The trainer handling teenagers will have a more predictable opinion based largely upon the stimulus he must get from his achievement in increasing a young person's mobility.

There is therefore likely to be a wide variation of opinion between instructors training older people; and one can expect a measure of uniformity in the views of those teaching teenagers. When the reasons for these opinions are considered however there should be compatibility. Both will be based upon the observation of performance. Unless there is some objective measure for this there is little chance for fruitful discussion at a later date from which any conflict of views may be resolved. Where high performance was achieved we will want to know what this was and what variation can be expected at this level.

Clearly, there will be a wide variation in the mobility performance of the 250 people who are to be trained and it will be very difficult to assess the validity of individual opinions even with objective measures. Nevertheless, it is still the overall opinion which will count in the long run for it is this which determines the subsequent action. Objective measures, when analyzed, cannot help but exert some influence, however, and they may lead to greater uniformity of action by agencies for the blind.

Meaningful Measures

Mobility is a complex dynamic process which is influenced by innumerable factors, many of which are related to the individual's personality and his needs. One highly mobile blind adult recently confessed that he really gained little satisfaction from doing badly what a sighted child of ten finds so easy. The implications of this warrant a little thought. Let us not forget that in evaluating the sensory aid and in training blind people to be mobile we are dealing with individuals, not the "average blind man" who does not exist.

The evaluation by Crause and Leonard of the Client Output of the Midlands Mobility Centre, Birmingham[1] does however show how an analysis of a group of people can be given meaning by dividing them into sub-groups through performance levels. When this is compared with the measurement of mobility of young people at Shrewsbury[3] one finds that the latter analysis completely hides the individual variations because the sub-groups are predetermined. This leaves the reader with little concept of what performance was like.

Even so, the score sheets (Appendix C.b, pp. 22-23) of the Shrewsbury study does provide a means for assessing the performance of the individual in a way which might reduce the variation in the judgment of the observer. This is needed if the method of evaluation used at Birmingham were to be adopted in this exercise. There is of course a great deal in both these studies which is relevant here.

Whilst we seek to evaluate a sensory aid the essence of the present exercise is to determine just how this affects the travel performance of the individual. We should therefore concentrate on this aspect.

The processes of training and evaluation conflict. The former demands attention from the instructor; he is constantly seeking to show his student how to correct faults or mistakes whilst encouraging and rewarding achievement. This allows no time for the recording of performance measures; the two cannot be done well simultaneously. We are thus faced with obtaining measures after each stage of training is completed; this is the method adopted by Crause and Leonard. They decided upon six levels of achievement in mobility which seem to be highly relevant.

These are:

1. Basic mobility skills
2. Indoor travel
3. Residential travel
4. Local shopping areas, simple bus trips, pedestrian crossings
5. Advanced business areas, bus routes, traffic-light crossings
6. Town centre

The basis scores were:

a. The final level (1-6) of achievement reached by the client as judged by the instructor

b. The number of hours spent by each client to reach each level to the satisfaction of the instructor

From a knowledge of the results so far with the cane and the sensory aid combination, it is believed that a significant improvement in performance over that obtained in the Birmingham exercise should be possible. Were this shown to be so, it could be said the measures were meaningful.

The use of "Score Sheet A" would help the instructor to make repeatable judgments on achievement and the variation between individual judgment should be small. The VARIABLE in the exercise would be only TIME to Train; performance becoming a constant for each stage. This is an important consideration.

Whatever the aid may do for the individual as an environmental sensor it has little relevance here except where it contributed directly to mobility performance. Where there is value in sensing the environment for its own sake, this can only be judged by the user and his individual opinion is all we can go by. We can however attempt to measure the acuity of perception using the sensory aid but this is a particularly difficult task requiring a detailed knowledge of the device parameters. Only a small specialized team working with a few blind people is likely to succeed in this part of the exercise. The Canterbury team hope to be largely preoccupied in this direction.

Proposed Objective Mobility Measures

If people are going to vary in their mobility performance, this is most likely to be in level of achievement rather than how well a specific task is executed. There will of course be variation in travel performance between subjects in any given type of area, but if travel is to be regular and maintained over a period of time it must be above a critical minimum level. This will tend to be smooth and relaxed travel for the majority in the group. If it were below the minimum level there will be a tendency for the travel ability to decline and probably cease.

The time taken to reach each level of performance should therefore be used in this evaluation exercise.

Score sheets are provided.

Score Sheet I (Appendix C.a, p. 16) is to be used to indicate when each task in the controlled are lessons 1-3 has been executed satisfactorily.* It is not expected that all subjects will do all the exercises but each exercise completed should be ticked off.

* Controlled Environment exercises are described in Appendix C.c, pages 24-26, and some photographs of these exercises are shown in Appendix C.d, pages 27-33.

With Score Sheet I are two charts (Appendix C.a, pp. 17-18). One is to be used to indicate the accuracy of localization. The other is to be used to show how well a subject is able to grasp a pole.

The complex pole exercises are to be scored where used.*

Score Sheet II a-b (Appendix C.b, pp. 22-23) is to be used for each of five stages.

Stage I - Residential
Stage II - Built up area (industrial)
Stage III - Pre-business area
Stage IV - Advanced business area
Stage V - Drop off

Each Score Sheet should be constructed for the route and a large scale map of the route is to be returned with the score sheets.

A film record should be taken of the routes and two subjects are to be filmed travelling these. This will make possible a comparison of performance scores from each centre and some scaling can then be done before final analysis.

Each instructor will complete a questionnaire at the end of the exercise and the results will be analyzed to obtain an "average opinion."

Each blind person will complete a questionnaire too, from which a consensus of opinion may be obtained. The personality profiles will be compared with the results of the questionnaire to determine correlations.

Predictors will be obtained from the analysis of the score sheets and the personality profiles.

---

* Controlled Environment exercises are described in Appendix C.c, pp. 24-26, and some photographs of these exercises are shown in Appendix C.d, pp. 27-33.

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2. Dupress, John, Sensory aids evaluation--procedures and instrumentation, Sensory devices for the blind, St. Dunstan's, 1966, p. 3.

3. Leonard, J. A., and R. J. Wycherley, Towards the measurement of performance of travel skill. Proc. of Conf. for Mobility Trainers and Technologists, M.I.T., 1967.

4. Proceedings of the International Conference on Sensory Devices for the Blind, St. Dunstan's, London, 1966.

5. Sharpe, R., The evaluation of the St. Dunstan's manual of instruction for the Kay sonic aid, Dept. of Psychology, University of Nottingham, 1969.

BINAURAL AID EVALUATION 1971-72

CENTRE ....

SCORE SHEET I

OBSERVER .... SUBJECT ....

SEX ....

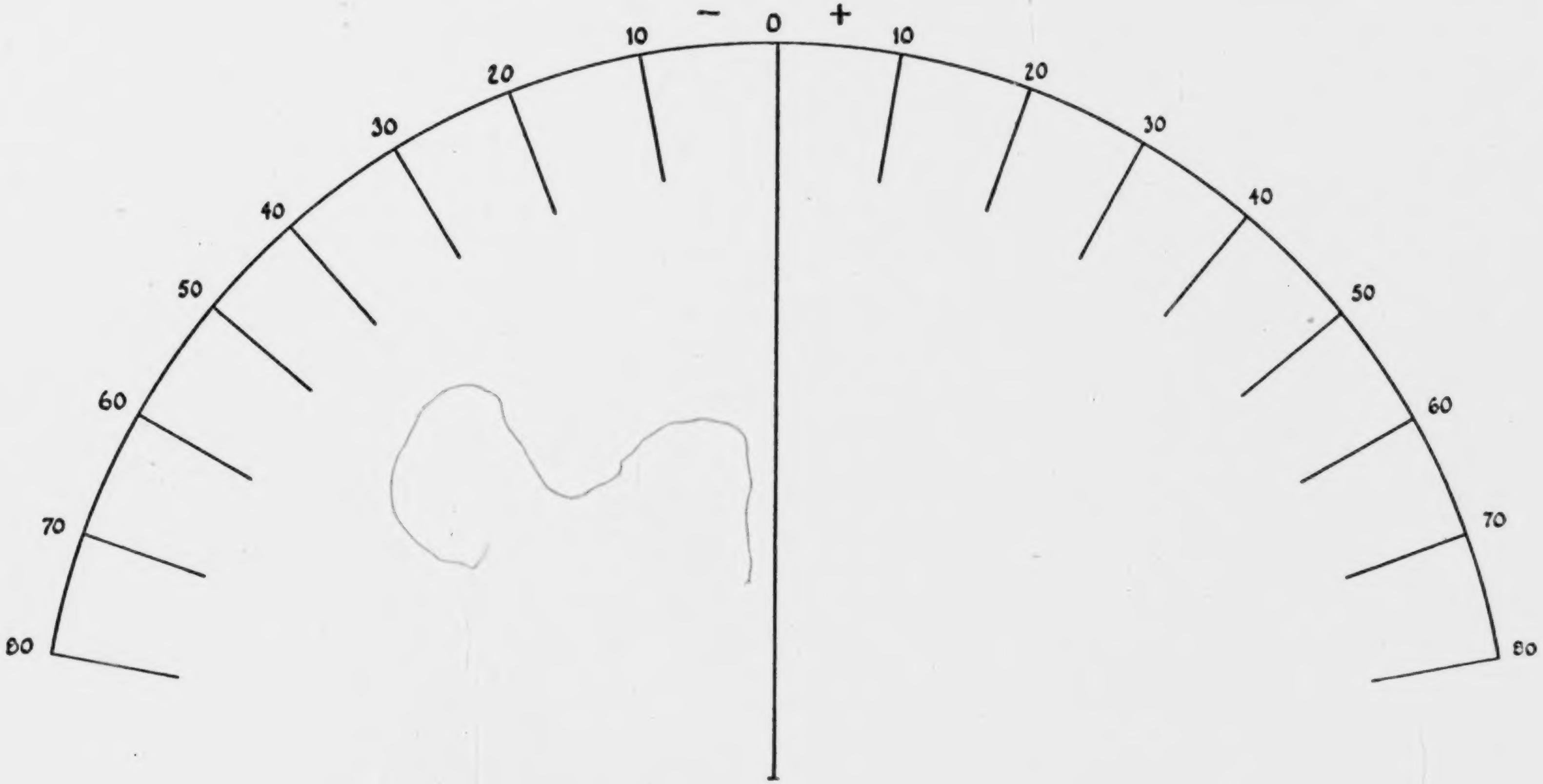
DEGREE OF VISION .... DATE OF BIRTH ....

ONSET .... HRS OF TRAINING ....

OTHER IMPAIRMENT ....

	a	b	c	d	e	f	g	h	i	j	k	
LESSON 1 Perpendicular												
LESSON 2 Parallel												
LESSON 3 Combination												
COMPLEX POLE TASKS												

NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
POLE POSITION	+10	-20	-30	0	+30	-10	+10	+20	-30	-10	0	-20	+30	+20
NO.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
POLE POSITION	0	+10	-30	0	-20	+10	+30	-30	-10	-10	-20	+20	-30	+20

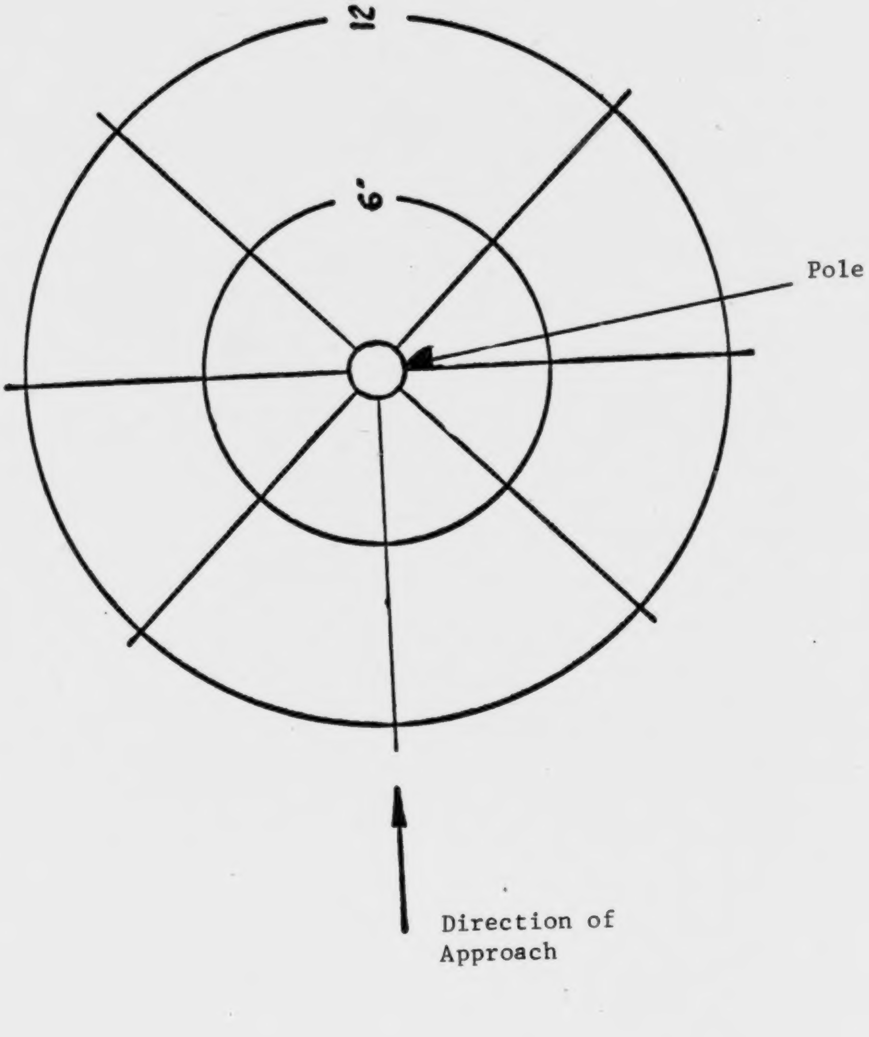


–
0
+
10
20
30
40
50
60
70
80
10
20
30
40
50
60
70
80

DIRECTION TRAINING SCORE CHART   Mark direction for each judgment

SCORE CHART FOR GRASPING POLE

Mark position of hand for each attempt
with "No." of attempt, e.g., (7)



12"
6"
Pole
Direction of Approach

LOCALIZATION TRAINING

Objective:

To teach the direction cue and correct for distortion of "field of view".

Procedure:

Part I	Use protractor painted on ground as per diagram. Stand subject at centre of curvature marked "0" facing towards 12 o'clock. Place 1" diameter pole in position according to evaluation chart for first test. Tap pole with stick and ask subject to point with cane at the pole. Record direction indicated with No. of Test. Move pole to next position and repeat.
Part II	Repeat pole positions but do not record. Subject to point to pole then be guided to "touch" position with cane as required (i.e. swing "left" or "right"). Note consistent errors.
Part III	Subject to stand at point "0" with aid "off". Place pole in position according to evaluation chart. Subject to switch on aid but not move head. Ask subject to point to pole with cane but not swing it in an arc. Record direction of pointer by inserting No. of Test. Repeat for all positions switching aid off during repositioning of the pole.
Part IV	Repeat Part II but do not record direction. Subject to point at pole then be guided to touch position as required. Note consistent errors.

Observations:

The subject is given feedback during Parts II and IV so as to correct for errors.

If distortion of the field of view persists the splay angle or the internal volume settings are to be adjusted to correct for this - to be carried out under supervision until proficient.

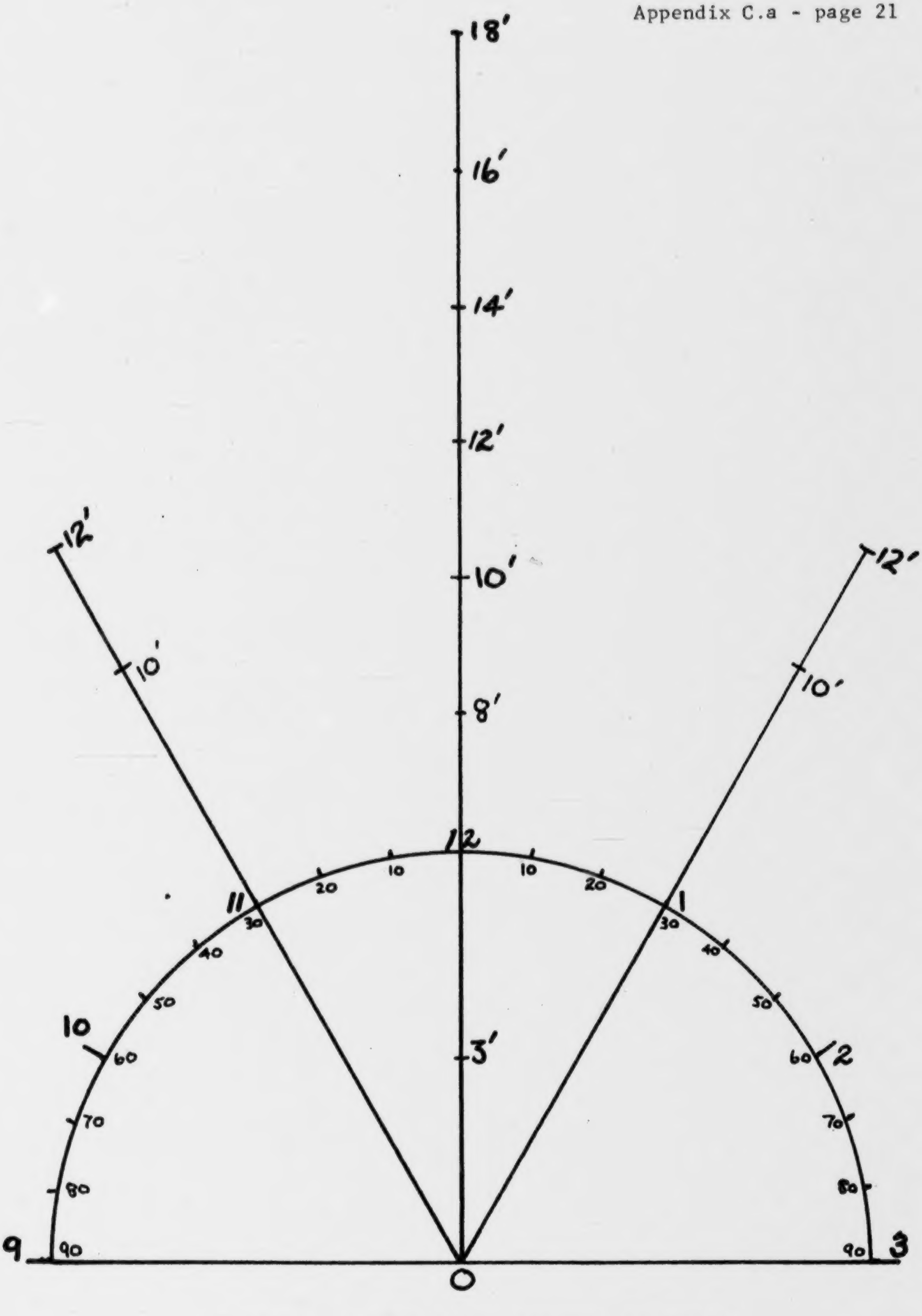
EVALUATION OF LOCALIZATION

Objective:

To assess directional accuracy.

Procedure:

Use protractor painted on ground as per diagram.
Stand subject at centre of curvature marked "0" facing towards 12 o'clock; the aid to be switched "off".
Place 1" diameter pole in position according to evaluation chart for first test.
Switch on aid - subject must not move head.
Subject to point with cane to position of pole. The cane must not be swung in an arc after pointing.
Record direction of pointing on chart inserting the No. of test (e.g."9") in direction indicated by subject.


18'
16'
14'
12'
10'
8'
3'
12'
10'
12'
10'
12
10
20
10
20
11
1
30
30
40
40
50
50
10
60
60
2
70
70
80
80
9
90
90
3
0

Protractor painted on ground for Field Test of Localization.

BINAURAL AID EVALUATION 1971-72

CENTRE.........................

SCORE SHEET IIa STAGE........................

OBSERVER .... SUBJECT'S NAME.........................

SEX...................

DEGREE OF VISION.................... DATE OF BIRTH.................

ONSET............................... HRS OF TRAINING...............

OTHER IMPAIRMENT.................... TIME FOR COURSE...............

SECTION OF TEST ROUTE	Crossings	Up Kerbs	indent. correction	correct path	position	Bump wall off kerb	obstacles	detours	indentation	down kerb	square up	listen	mobility grade	time over section	

BINAURAL AID EVALUATION 1971-72

CENTRE........................

SCORE SHEET IIb STAGE..............

ASSESSMENT

SUBJECT'S NAME........................

1.	PAVEMENT POSITION	: Mid	( )	Wall	( )	Kerb	( )
2.	DOWNKERB DETECTED	: Anticip.	( )	Cane	( )	Falls	( )
3.	SQUARE ON KERB	: Yes	( )			No	( )
4.	LISTENS BEFORE CROSSING	: Yes	( )			No	( )
5.	CROSSES	: Straight	( )			Veers	( )
6.	CORRECTS VEER	: Yes	( )			No	( )
7.	UPKERB DETECTED	: Anticip.	( )	Cane	( )	Falls	( )
8.	UPKERB DRILL	: Yes	( )			No	( )
9.	INDENTATION	: Yes	( )			No	( )
10.	INDENT CORRECTION	: Yes	( )			No	( )

OBSTACLES DETECTED

11.	AUDIT	: Yes	( )	No	( )
12.	TACT	: Yes	( )	No	( )
13.	OBSTACLES DETOURED	: Yes	( )	No	( )
14.	TRAVELS STRAIGHT	: Yes	( )	No	( )
15.	BUMPS WALLS	: Yes	( )	No	( )
16.	FALLS OFF KERBS	: Yes	( )	No	( )

GENERAL COMMENT: ....

....

....

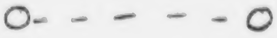
....

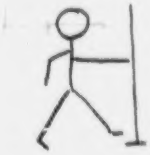
....

CONTROLLED ENVIRONMENT

Lesson 1 - Perpendicular exercises (poles)

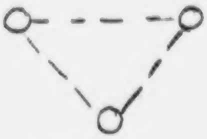
a.



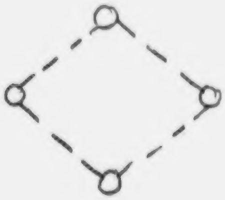


Touch Distance

b.

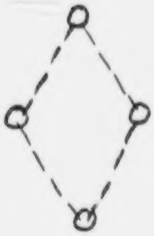


c.

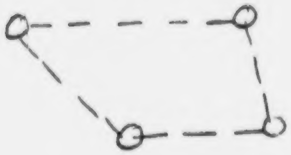


May proceed to:

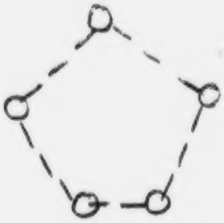
d.



e.



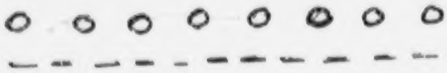
g f.



May place trainee in centre of pattern and have him identify shape by location and pitch relationships of signals.

Lesson 2 - Parallel exercises (poles)

a.



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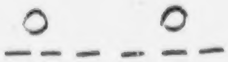

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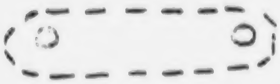

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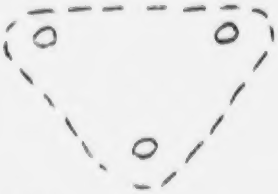

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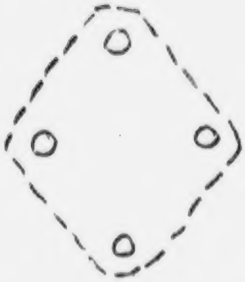

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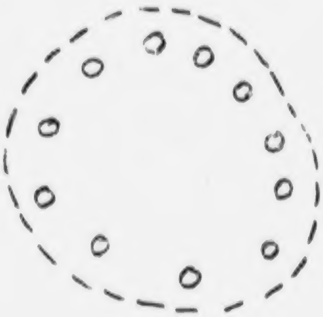
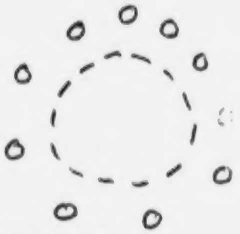
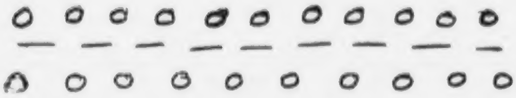


g.

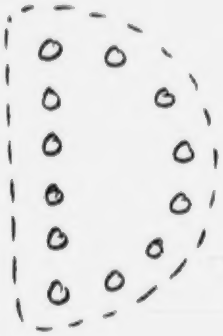


h.

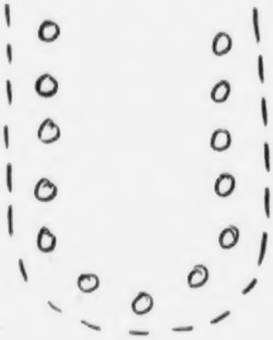


May proceed to:

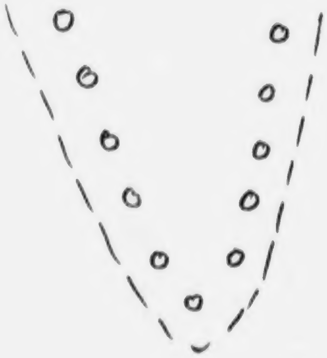
i.



j.

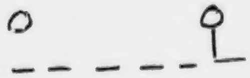


k.

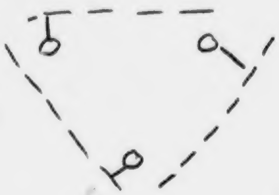


Lesson 3 - Combination parallel, perpendicular exercises (poles)

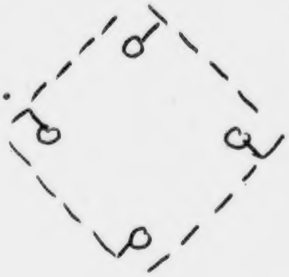
a.



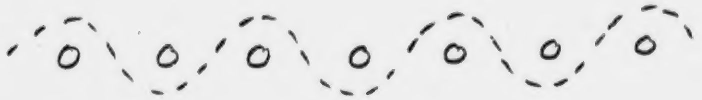
b.



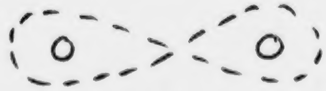
c.



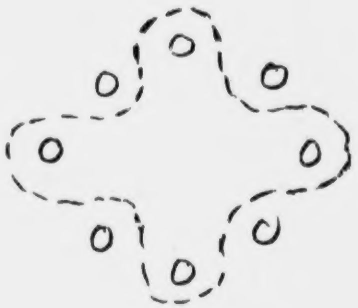
d.



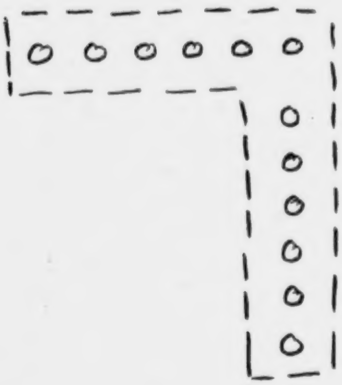
e.



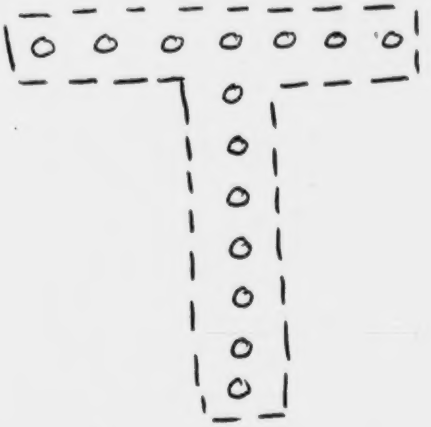
f.



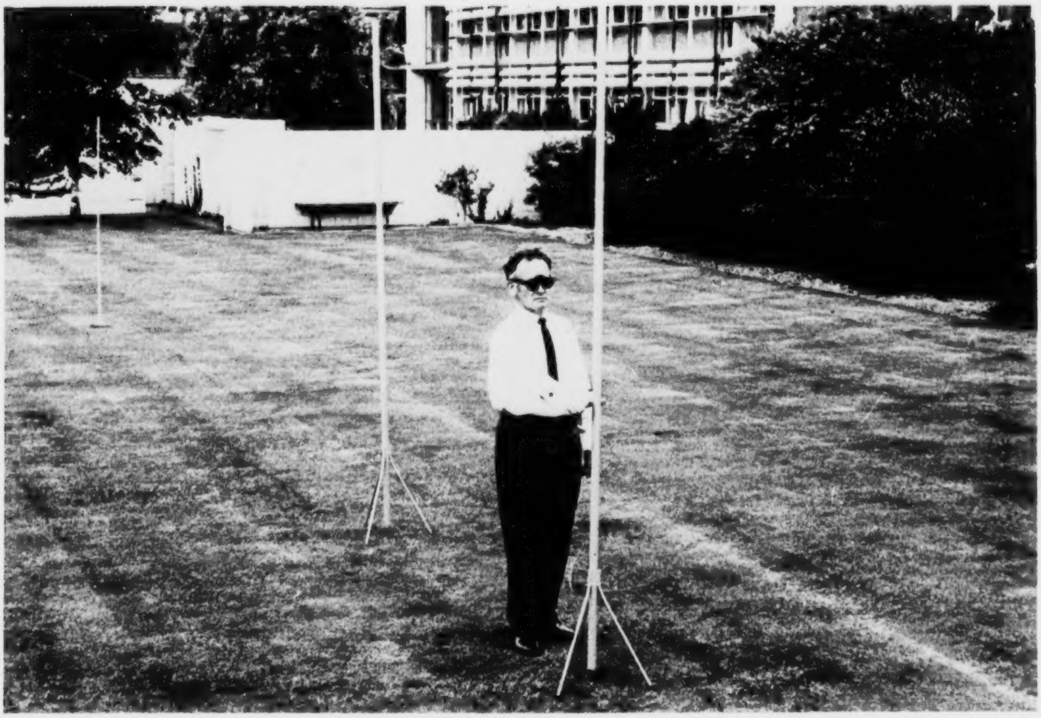
g.



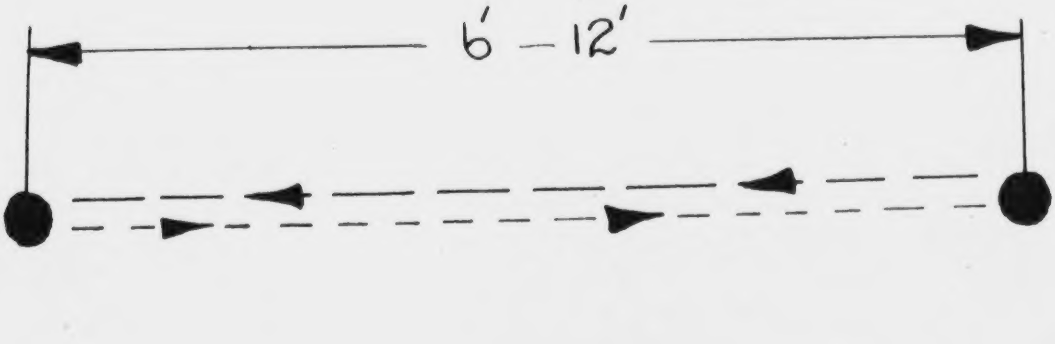
h.

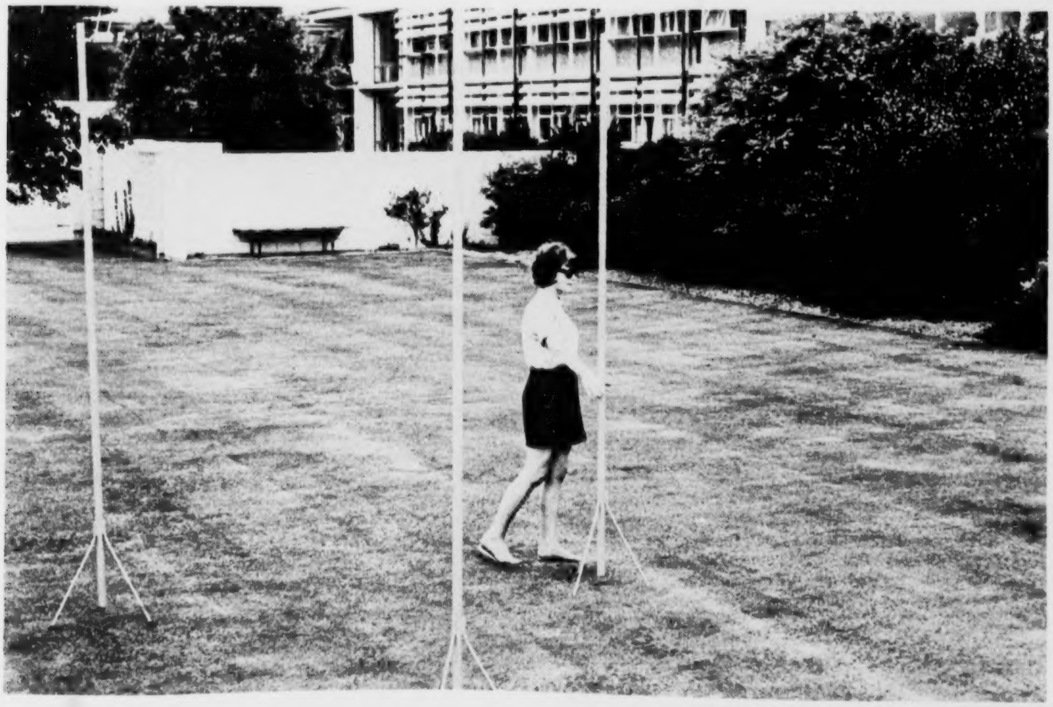


Note: Succeeding lessons will utilize Sonic Aid initially, latter portion of lesson, both Sonic Aid and long cane. The dual approach is thought to facilitate smooth combination of the cane/aid system while providing basic sonic learning experiences in the controlled environment.

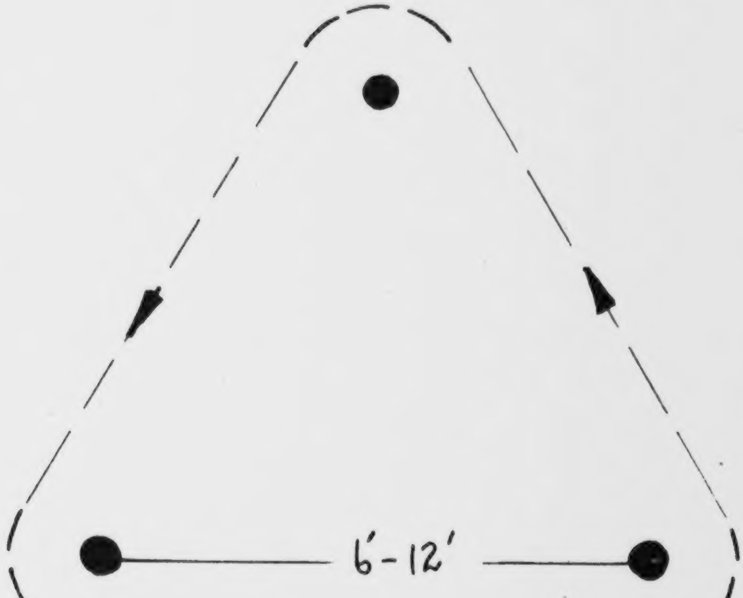


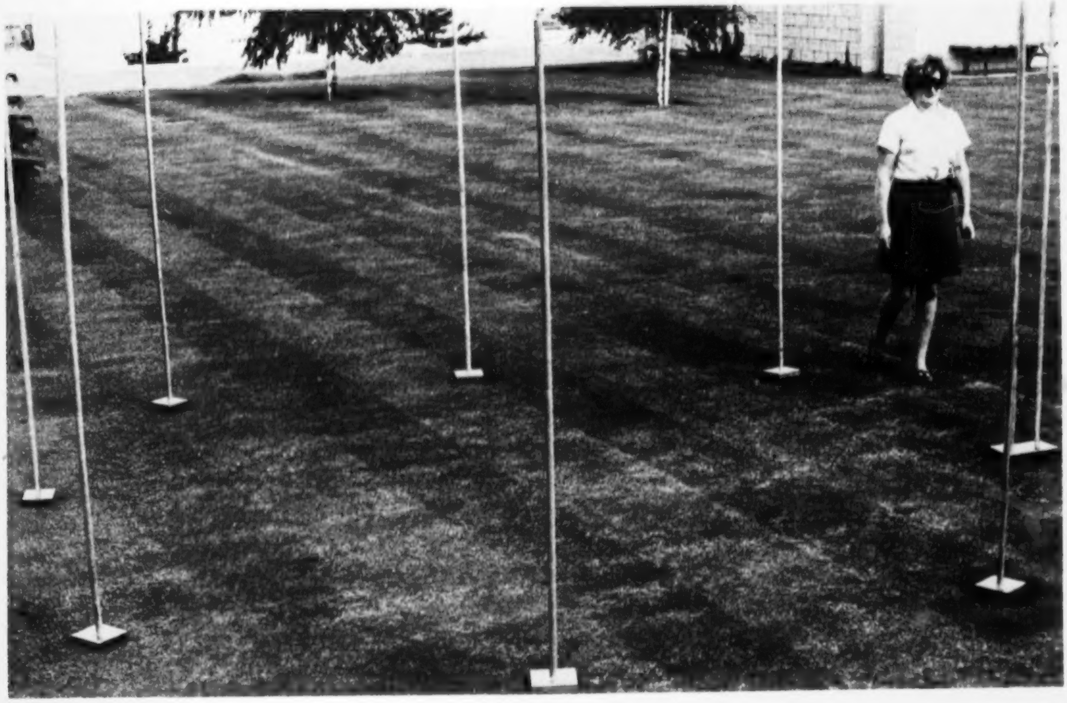
Walking between two poles and grasping them. (perpendicular exercise lesson 1 a)



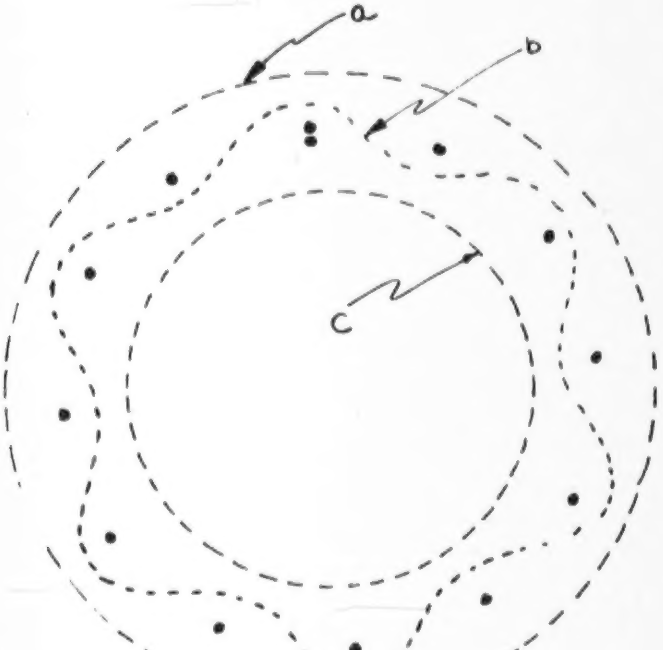


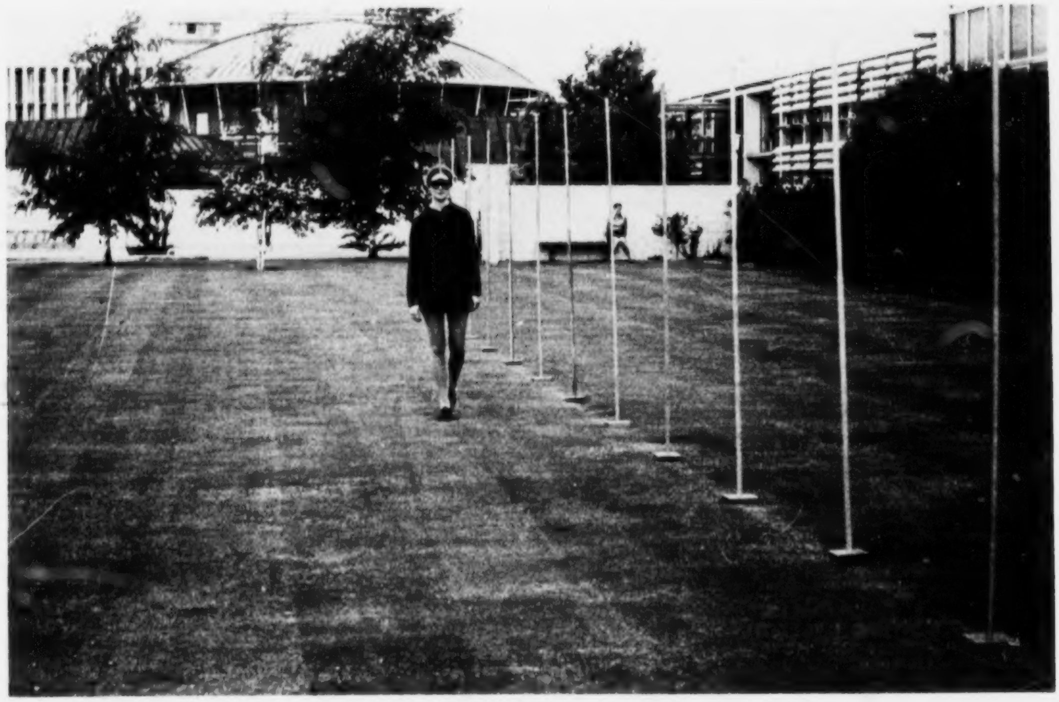
Walking round three poles (combination of perpendicular and parallel exercise lesson 3 b)



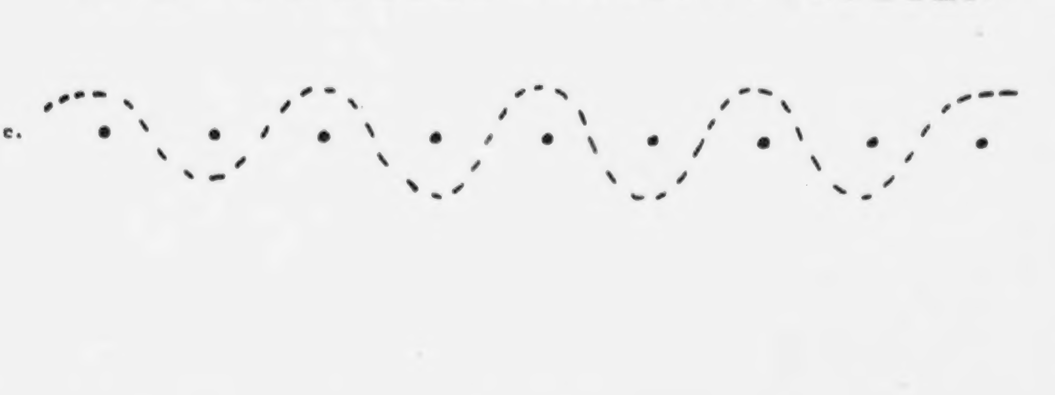


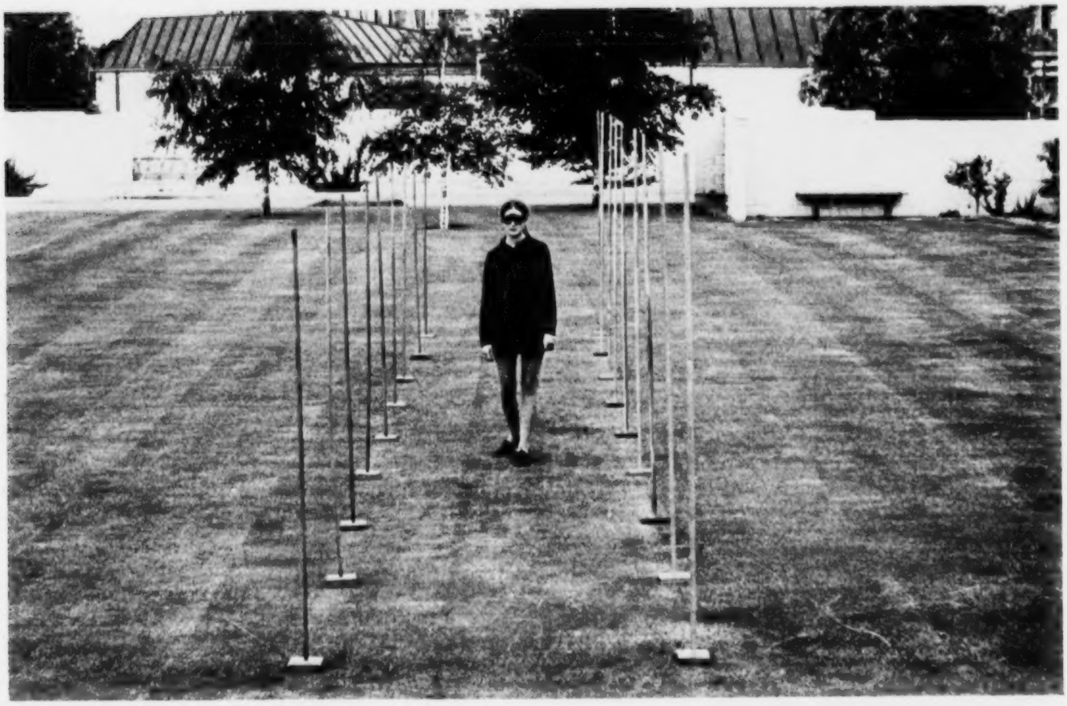
Walking round a ring of poles (lesson 2 f & g and Lesson 3 f)





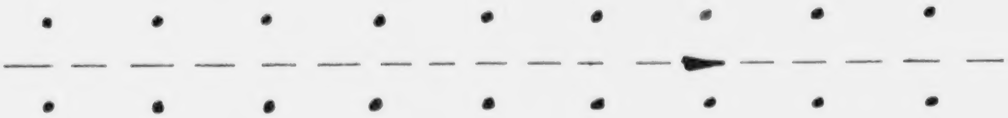
Walking along a row of poles (lesson 2 a and lesson 3 d)



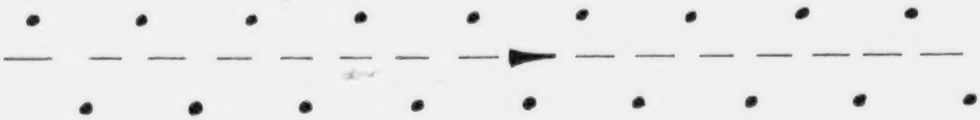


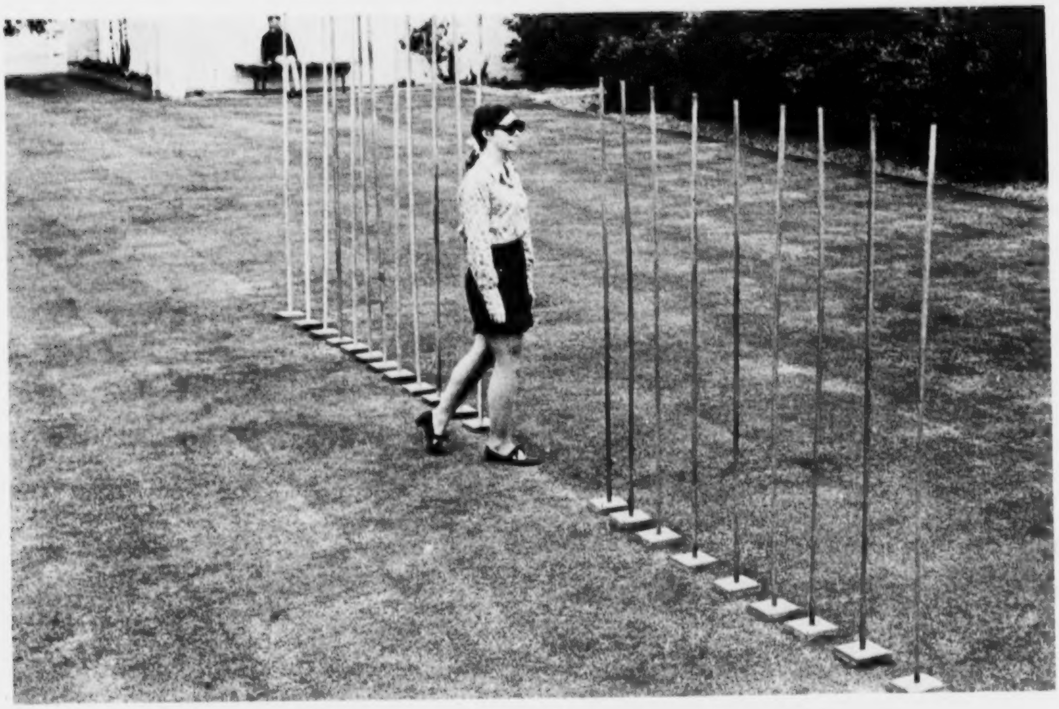
Walking between two rows of poles
(lesson 2 g)

a.

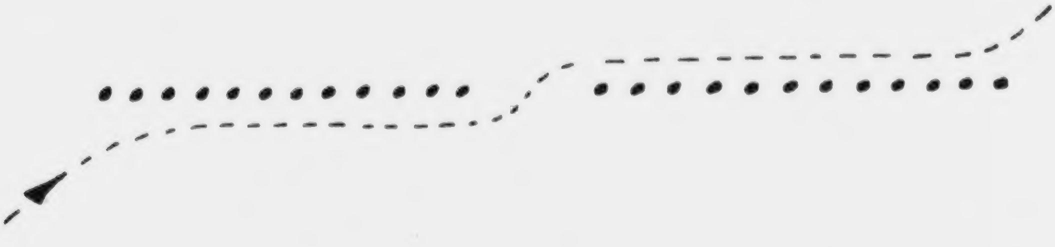


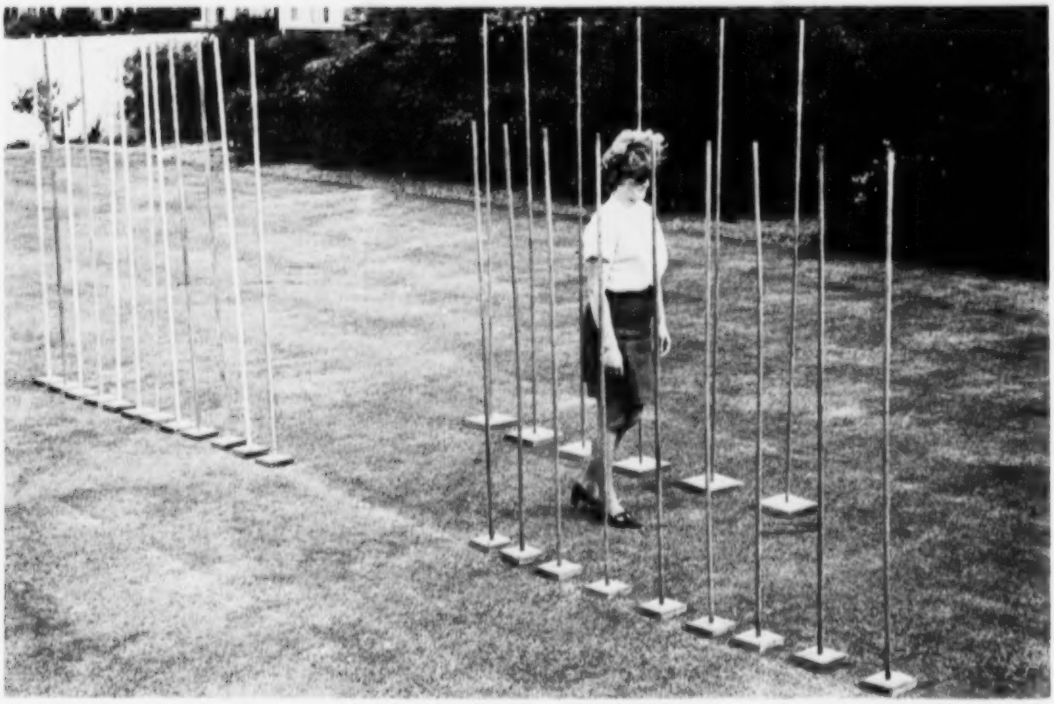
b.



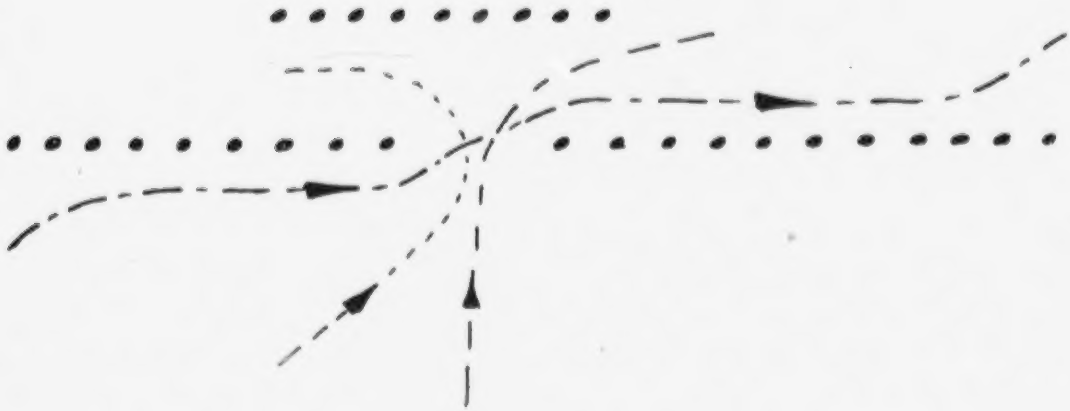


Finding gap in "wall" of poles.
Complex pole task.





Walking in complex pattern of poles.



APPENDIX D

INSTRUCTION MANUAL

DEARING LIGHT SENSING TYPHLOCANE
MODEL LST-3

for
Research & Development Division
Prosthetic & Sensory Aids Service
Veterans Administration
252 Seventh Avenue
New York, New York, 10001

Purchase Order No. 11,271R
Veterans Administration Hospital
First Ave. at E. 24th St.
New York, New York, 10010

by
L.M. Dearing Associates, Inc.
12324 Ventura Blvd.
Studio City, California, 91604

October 1971

DEARING LIGHT SENSING TYPHLOCANE
MODEL LST-3

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1. Description Page 1
2. Construction Page 1
3. Detailed Specifications Page 1 & 2
4. Operation Page 2 & 3
5. Practical Situations Page 3 & 4
6. Maintenance Page 4
7. Warranty Page 4

Figure 1 - Schematic Drawing - Dearing Light Sensing Typhlocane Model LST-3

Figure 2 - Photographs - Dearing Light Sensing Typhlocane Model LST-3
    2a - Canes
    2b - Light Sensing Probe and Tip End

Figure 3 - Photograph - Dearing Light Sensing Typhlocane Model LST-3
Handle & Controls with Speaker, Jack & Thong - Upper Portion

DEARING LIGHT SENSING TYPHLOCANE
MODEL LST-3

1. Description:

The Dearing Light Sensing Typhlocane Model LST-3 carries a probe near the tip of the cane coupled to 3 switchable photo cells which detect and provide auditory tone cues for differences in reflection (light patterns). Bright patterns or surfaces give a a high tone, dark patterns or surfaces a lower tone. The sound cues are received by the blind user via an earphone or through a speaker in the top of the handle.

The Light Sensitive Typhlocane when used with normal mobility techniques will provide a blind user some extra information about his immediate surroundings. As a mobility aid to the blind it will detect and allow the blind user to follow painted crosswalk markings such as found at street interchanges. It also provides extra cues to the blind user for most path edges, curbs, etc., while traveling with the swing and touch techniques recommended in long cane mobility training.

Sensitivities of the light sensing probes cover a wide range to facilitate useful probing with illumination levels of 10,000 fc of bright sunlight to 0.1 fc of night street lighting. This corresponds to reflection surface brightness of from 2000 to 0.02 ft. lamberts - a range of approximately 100,000 to 1.

The strength is similar to a standard typhlocane and it should be used in the same way as a long cane. The weight, with speaker, is somewhat greater than the typhlocane. However, the balance point is closer to the normal gripping point (handle end.)

2. Construction:

The lower 3/4 of the Model LST-3 cane is made of tapering tubular fibreglass. The tip is of nylon inserted into an aluminum light sensing tube with entrance pupils 2 inches from the nylon tip end. Inside the cane body are three independently switchable photocells varying in spectral as well as overall sensitivity. These provide good aural tone cues under ambient illumination ranging from sunlight through interior, artificial to bright night street lighting. For traveling the tip is intermittently touched or is raised a few inches above the surface of the ground in the usual long cane technique.

Its rugged construction allows it to make rough contact with ground or solid objects in the same ways as the ordinary typhlocane. Like the long typhlocane - it can be broken. Should the tip receive major damage, i.e., caught in the gap between the hinges of a partially opened door, crushed by a car, etc., the fibreglass cane and cells can be replaced at the factory. The circuits and major components are near the handle.

3. Detailed Specifications:

3.1) Body - tubular fibreglass tapering in diameter from approximately 5/8 to 13/16" from the tip to the handle section. The handle is of tubular aluminum (holding three rechargeable batteries) covered with a rubber golf grip. The handle is closed at the top with a speaker cone which carries speaker, and the earphone and battery recharging jack.

3.2) Length - 48" to 56" as ordered. Weight - 13 or 14 oz. with batteries and speaker, 10.5 to 11.5 oz. without speaker.

3.3) Balance - 36" from tip on 52" cane vs. balance 32" from tip on typhlocane of similar length.

3.4) Tip - replaceable nylon - 1" exposed, 1" threaded to go in probe section.

3.5) Grip - flat distinguishable golf grip - same as typhlocane.

L. M. DEARING ASSOCIATES, INC.
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3.6) Cells - three calibrated photo resistive cells which provide spectral sensitivity range extending from the blue through the deep red end of the visual spectrum.

3.7) Probe - reflected light enters the cane through three 3/32" diameter apertures which are integral with the aluminum tip. The probe holes are 5/16" deep and exit 2" from the end of the nylon tip. They provide an approximate 15° acceptance angle. Fibre optic conducts the reflected light to the three photocells located in the body of the cane. These cells are potted in plastic for protection against banging.

3.8) Auditory signal display - this signal varies in pitch or sound frequency going from a low frequency (50 H_z) for dark objects, to higher frequency (2000 H_z) for highly reflective objects. A small 0.1 watt speaker is mounted in the top of the cane with volume sufficient to be heard in normal situations. A lightweight earphone which is hung over the ear shell has a three-foot extension. It is plugged into a small jack at the speaker which it then cuts off for easier recognition of aural cues in noisy situations or where privacy is desired.

3.9) Sensitivity - A 25% change in pattern light reflectivity (± 0.10 reflective density) will be readily recognized as an auditory change in pitch. A 95% change in pattern light reflectivity (reflective density change of 1.30) results in a change from highest frequency tone to the lowest at each of the three switchable cells.

3.10) Power & Recharging - Three rechargeable 500 ma hr. Nickel Cadmium AA cells provide capacity of 30 hours operation between recharging. A 110V 60 H_z AC plug-in, 50 ma charging unit is furnished with the cane. It is plugged into the earphone jack on the speaker shell.

3.11) Controls - 1) an on/off switch with volume control.
2) cell selecting 4 step switch to set for light condition.

Step 1 - Daylight (Low Sensitivity Blue Green Sensitive Cell)
Step 2 - Shadows & interior (Medium Sensitivity Green Cell)
Step 3 - Low level interior (High Sensitivity Red Sensitive Cell)
Step 4 - Night street lighting (All three cells combined)

4. Operation:

4.1) On-off volume control switch - nearest handle has an audible click for on-off. Off - pointer toward flat grip side of cane. Volume - turn clockwise.

4.2) Light level switch - four positions - each with audible click, advance clockwise through positions 1,2,3,4 to stop, then counter clockwise 4,3,2,1.

4.2.1) #1 switch position - pointer towards flat grip side of cell is most sensitive to blue green light range - 5,000 to 15 foot Lamberts of reflected light. Good for sunlight and open shade.

4.2.2) #2 switch position - pointer 30° clockwise - cell is most sensitive to green light range—700 foot Lamberts to 1 foot Lambert - good for interiors, particularly with fluorescent lighting.

4.2.3) #3 switch position - pointer 60° clockwise - cell is sensitive to deep red light, range 4 foot Lamberts to 0.10 foot Lamberts - good for interiors with low level incandescent (Mazda) lighting and streets with incandescent lighting.

4.2.4) #4 switch position - pointer 120° clockwise - switches in all three cells so that spectral sensitivity range extends from blue through deep red part of visual spectrum - useful for low light levels incandescent and in favorable situations, mercury street lighting over white crosswalks.

4.3) Earphone - plugs in at jack in speaker housing at top of cane. Use in noisy situations and whenever privacy from speaker broadcasting is desired.

4.4) Recharging batteries - can be done each night or after 30 hours operation. First turn volume control to "off". Then, plug recharger prongs into 110-120V 60 cycle AC outlet. Next, plug small plug into jack on speaker housing (same one that is used for earphone). A slight popping noise indicates that the charging current is operating. Charging rate is 50 ma per hour, 10-15 hours to full charge. Longer charging times will not damage batteries.

4.5) The LST-3 cane including the speaker is reasonably waterproof, but protection from a complete dousing is suggested.

5. Practical Situations:

The aural tone increases in pitch as surface brightness increases. This leads to some typical cues. The most important is for street corner crossing lines (see 5.1).

5.1) Street Corner Crosswalk Stripes - pavement with white or yellow lines:

#1 cell setting for sunlight
#2 cell for darker, cloudy daylight
#4 (all cells) for night street lighting

Cue: Low - to high - to low pitch sound as crosswalk stripe is scanned, repeating back and forth in usual long cane mobility technique.

5.2) Curb - approaching from sidewalk level - same cells as in 5.1.

Cue: Normal, medium or background pitch to a lower tone or pitch.

5.3) Dropout and cracks in sidewalk.

Cue: Medium - to lower - to medium pitch sound.

5.4) Doorways - unlit.

Cue: Medium to lower pitch sound.

5.5) Doorways - opening from hallway into room brightly lit - #2 or 3 cell.

Cue: Medium to higher pitch sound.

5.6) Path borders - grass border - that is more reflective than path.

Cue: Medium to high pitch sound, repeating as border is scanned.

5.7) Building or wall border that is darker than path being traveled - any cell.

Cue: Medium or lower pitch sound than found over path.

5.8) Shadows - your own.

Cue: Medium - to low - to medium pitch sound as you scan across in usual long cane mobility technique. Might be used knowing time of day (and with the sun generally behind blind traveler) to estimate direction of travel as points of compass--W, NW, N, NE, E.

5.9) Shadows - buildings, posts, trees, etc.

Cue: Shift to medium to lower pitch sound, then the probes give the above aural cues for light patterns--5.1) to 5.6)--at a lower frequency. Shadow edge can be scanned to estimate direction (E, SE, S, SW, W) with sun location ahead of traveler. Shadows can also be used for locating purposes relative to the object casting the shadow, can be associated with temperature change on hand or face, or explore tactily to determine the object casting shadow. A high degree of training will be required for interpreting shadows.

Future models of LST mobility aids may have a feature to eliminate the effect of large shadows if it proves to be desirable.

6. Maintenance:

The nylon tips are easily replaced by the user. No other maintenance is expected beyond a yearly change of the Nickel Cadmium batteries and an occasional cleaning of the light sensing holes in the tip. The three 3/32" probe apertures should be occasionally cleaned with dishwasher detergent and water using small cotton swabs or "Q-Tips".

Though the cane is designed for ready maintenance and repair, it should be returned to L. M. Dearing Associates, Inc., for repair and recalibration at our standard repair rates.

The Dearing plant maintains a complete stock of replacement items, such as calibrated photo cells, electronic and mechanical components, plus the test equipment and optical benches needed for repair and recalibration of the Model LST-3 cane.

7. Warranty:

All units are warranted by L. M. Dearing Associates, Inc., against any patent defects for a period of forty-five (45) days and against any latent defects not caused by usage wear for a period of one (1) year. Warranty period begins on date of original shipment from the Dearing facility in Studio City, California.

Warranty is void if damage is caused by abnormal usage, violation of the instructions which accompany the unit, or alteration and/or repair by other than L. M. Dearing personnel.

Warranty is limited to the repair or replacement of those items which are returned transportation prepaid to the factory without further damage, and in the judgment of the Dearing Company are either originally defective or have become defective in normal use.

L. M. DEARING ASSOCIATES, INC.

October 19, 1971

LST-2-10/71

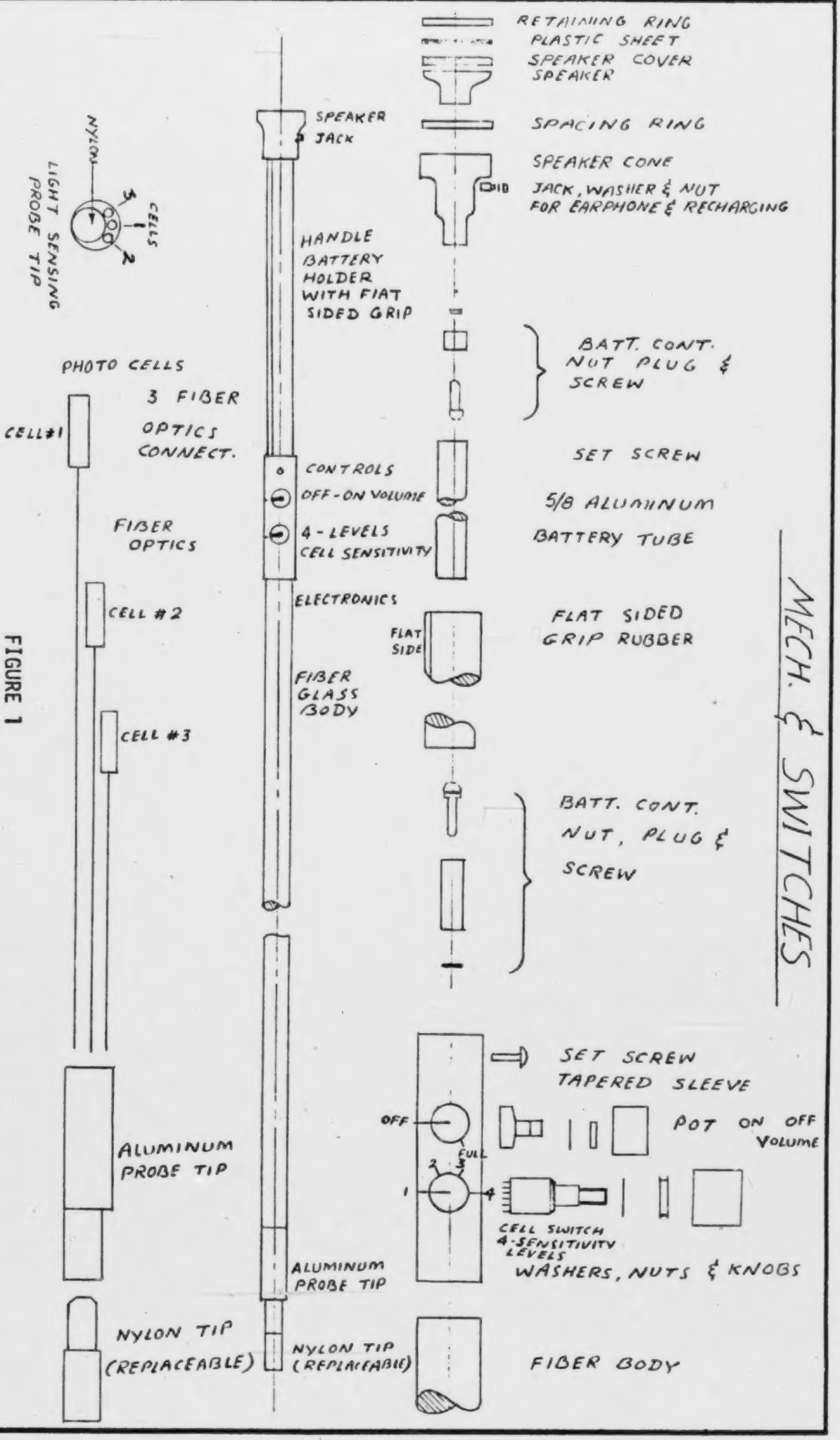
RETAINING RING
PLASTIC SHEET
SPEAKER COVER
SPEAKER
SPACING RING
SPEAKER CONE
JACK, WASHER & NUT FOR EARPHONE & RECHARGING
SPEAKER
JACK
HANDLE BATTERY HOLDER WITH FLAT SIDED GRIP
NYLON
CELLS
3
1
2
LIGHT SENSING PROBE TIP
BATT. CONT. NUT PLUG & SCREW
PHOTO CELLS
3 FIBER OPTICS CONNECT.
CELL #1
CONTROLS
OFF-ON VOLUME
4-LEVELS CELL SENSITIVITY
SET SCREW
5/8 ALUMINUM BATTERY TUBE
FIBER OPTICS
ELECTRONICS
CELL #2
FLAT SIDE
FLAT SIDED GRIP RUBBER
FIBER GLASS BODY
CELL #3
BATT. CONT. NUT, PLUG & SCREW
MECH. & SWITCHES
SET SCREW
TAPERED SLEEVE
OFF
FULL
POT ON OFF VOLUME
1
2
3
4
CELL SWITCH 4-SENSITIVITY LEVELS
WASHERS, NUTS & KNOBS
ALUMINUM PROBE TIP
ALUMINUM PROBE TIP
NYLON TIP (REPLACEABLE)
NYLON TIP (REPLACEABLE)
FIBER BODY

FIGURE 1

L. M. DEARING ASSOCIATES, INC.

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REVISED:

DRAWN BY: PC

APPROVED BY: L.M.D.

DESCRIPTION: DEARING LIGHT SENSING TYPHLOCANE MODEL LST-3

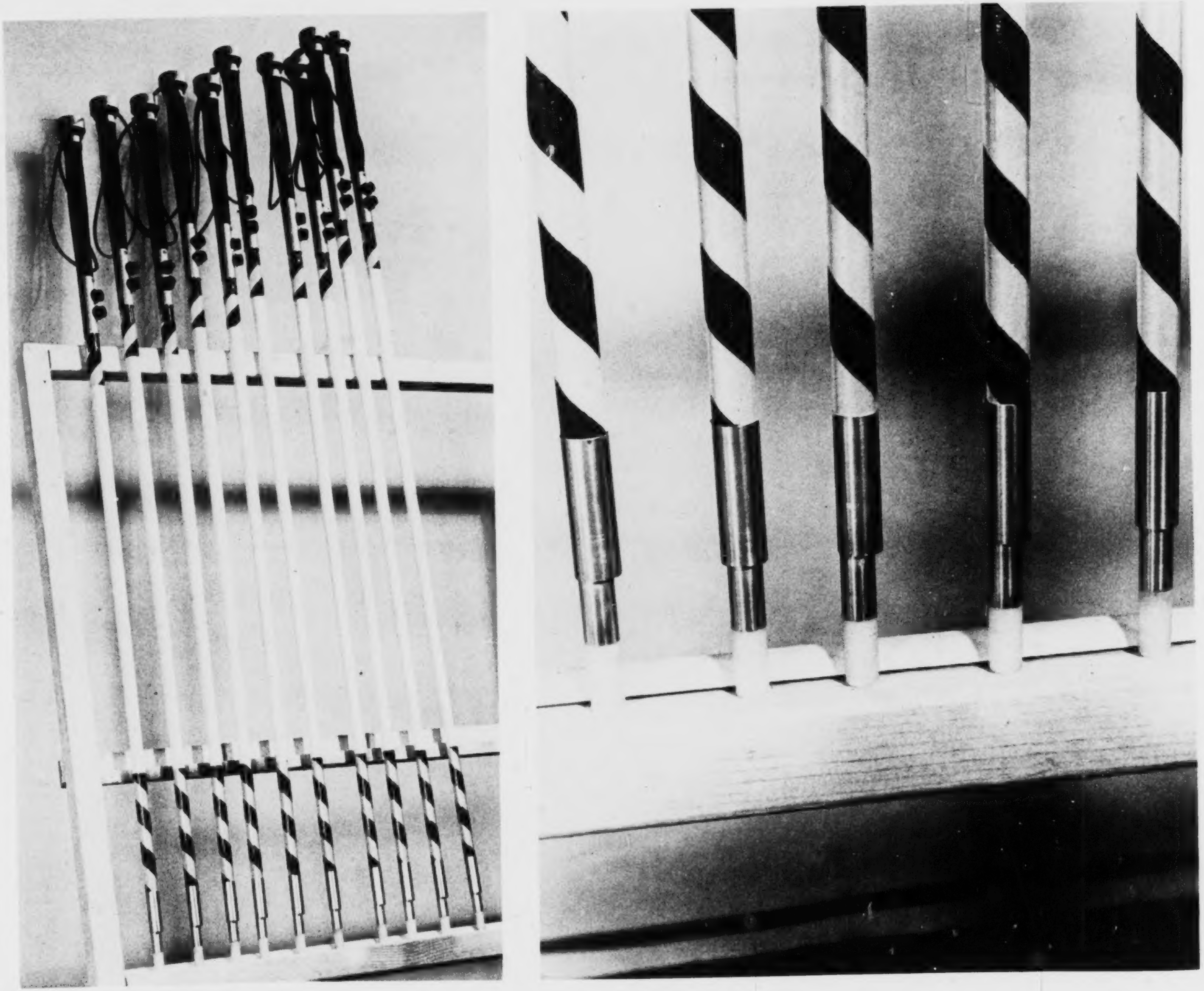
TOLERANCES UNLESS OTHERWISE NOTED ± None

SCALE: None

DATE: 8-27-71

WORK ORDER NO: 083

DRAWING NO: 083-4



2a. Canes

2b. Light-sensing probe and tip

Fig. 2. Dearing light-sensing typhlocane - Model LST-3.

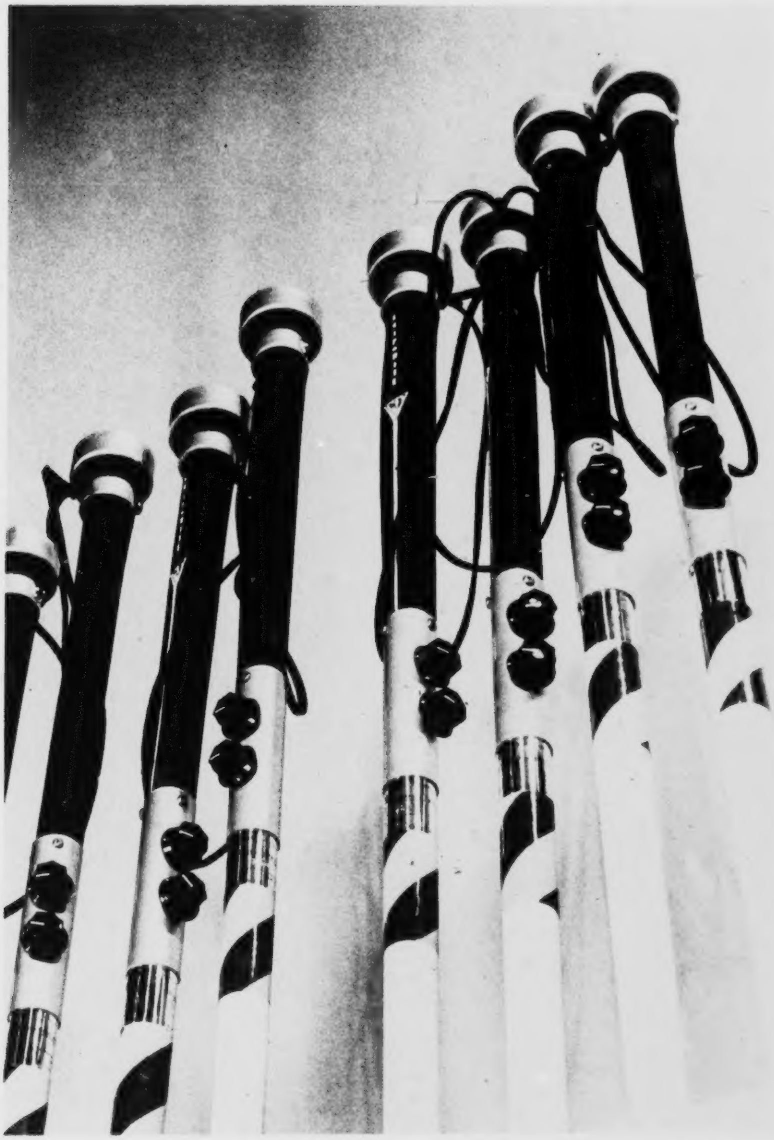


Fig. 3. Dearing light-sensing typhlocane - MODEL LST-3.
Upper portion--speaker, jacks, handle and controls.

THE EVALUATION OF THE VISOTONER

Harvey Lauer

It is a fact but not a complaint that over the years the field of sensory aids for the blind has resembled a junkyard of evaluation projects. For over four years, we have been teaching and testing reading appliances and their components, and we have made enough mistakes and discoveries to add to the field some litter and some valuable knowledge. I have been the only full-time person in the project during this entire period. My colleagues in the evaluation of the Visotoner are Margaret Butow, employed half-time in the project; Ann Chapman, who had a summer project in 1970; and Richard Bennett, who was recently hired full-time. Mary Jameson of Britain has shared her valuable experience with us. We have also engaged in the shake-down testing of reading machines, the development of training materials and lesson programs, Cognodictor and Visotactor evaluation, etc.; but in this paper we shall summarize the evaluation of the Visotoner.

For years I have also been an enthusiastic advocate of the direct-translation, audible-output optophone called the Visotoner. I am more enthusiastic now and also more aware of the great needs for development and evaluation in the field of reading appliances. I will spare you my testimonials and those of my students, shift verbal gears into the first person plural and concentrate on results, problems and recommendations.

This project is sponsored by the Prosthetic and Sensory Aids Service of the Veterans Administration. Dr. Eugene F. Murphy is Chief of the Research and Development Division. Those who are not fully acquainted with the project should read an article entitled "Personal Reading Appliances for the Blind" which I can furnish. It is also published in the October 1971 issue of The Braille Monitor published by the National Federation of the Blind.

LET'S PRETEND WE'RE EAVESDROPPING

The best way to introduce readers to both the project and some of its results is the unorthodox one of pretending that we are talking to a student about his future with the Visotoner. This paper will also be shared with all users and some former students of the Visotoner. Their thoughtful comments are hereby requested. In dialogue with the student, we would cover the abovementioned article and the following points. Of course, our perspective changes slightly with each new student. Here is our current perspective:

THE FOUR STAGES OF SKILL ACQUISITION

"We find it most helpful to view the learning of any skill in four stages. (1) The trial stage involves testing and acquaintance by everyone concerned. (2) The investment stage is more commonly called training or formal training. (3) The composite stage consists of investment plus growing utility. (4) The bonus stage is so named because it comprises efficient utility plus the bonus of further skill.

Now let us apply this process of skill acquisition to the Visotoner. Although we often test parts of reading systems in this project, and you may be invited to test some new design features, the major effort of the project is to train users of the Visotoner."

STEP ONE OF OUR TRAINING PROGRAM

The course has three steps. Step One is a tape-recorded Visotoner Screening Course developed and taught by Margaret Butow of the Hadley School for the Blind under sponsorship of the Veterans Administration. This is a 25-lesson home study course. The screening course can also be taught at Hines Hospital or the Menlo Park VA Hospital along with several hours of personal instruction to bring you through stage one of the learning process described above. In fact, this will bring us through stage one or the trial stage and into stage two which is the training stage.

At that point we will be able to tell you one of three things: (a) you have high ability to learn to hear the code, (b) your ability to learn this audible code is moderate, or (c) your ability to learn the code is apparently low. In the case of high ability, if you practice regularly, you should be able to complete the 200-lesson course in several months. That is usually the length of time for your second or investment stage of training. If your ability is moderate, it should take you from one year to eighteen months to complete the training stage. Of course, a good deal also depends on other abilities and motivating factors. In our experience, most people with moderate ability decide not to take the course. If your ability to learn the code is found to be poor, we are not permitted to offer the course of training to you.

THE SECOND AND THIRD STEPS OF OUR COURSE OF TRAINING

Steps Two and Three of our course cover Stage Two (the investment stage) of the learning process. Step Two consists of three weeks of individual instruction or its equivalent at Hines Hospital, at the Hadley School for the Blind, or at the Menlo Park, California, VA Blind Rehabilitation Center. In Step Three of our course, we work by phone and tape correspondence with each student who finishes reading the 200-lesson Battelle course in his home. We will also agree on other assigned projects in order to help you move from the second stage of learning the skill to the third or composite stage in which the skill begins to be of use to you.

Almost every student completes the course of training. He learns to read with the Visotoner. In the third or composite stage of learning process, however, we have lost about one third of our students. There are three main reasons for this loss. First, educators largely ignore the third and fourth stages of the learning or skill-acquisition process. As a result, we have only feeble encouragement to offer, and we even fail to alert people to the hazards in these stages. These hazards are overcome only by careful planning and execution of good working habits or by luck and determination. Second, this particular skill is new, and with our early students we overestimated the time it would take, after completing the course of training, for students to gain enough reading speed and other skills to accomplish many of their goals. Some students tended, therefore, to become disappointed with the instrument or their performance, thinking that perhaps they were under-achievers. Third, we cannot expect our present hardware to be fully useful to a large number of people until it is complemented with a character-recognition machine and other direct-translation machines for people with differing abilities and reading needs. This is explained in the Conclusion of this paper.

WHAT TO EXPECT

We are now able to tell you what to expect from this training and what is expected of you. We do not try to obligate students to continue training against their wishes; we do ask for honesty. We can give you a valid prediction of your future with the Visotoner, but since only 20 people have learned the skill we cannot guarantee success. For this reason, we work with people who have healthy, positive self-images so that failure would not be a crushing blow. All our students have plans for practical use of the hardware, and because of the necessary risks involved we naturally attract some students with pioneering spirits. That is simply another way of saying that many of our students enjoy challenges, and they prefer taking worthwhile risks and making large investments of effort either for their own benefit or in the service of others.

Upon completion of the 200-lesson course which takes about 200 hours, you can expect to read between five and twelve words per minute. Five words per minute is a lower limit, but twelve words per minute is not the upper limit, so do not let this statement form a barrier against greater achievement where possible. Speed depends as much on motives and acquired habits as on ability, but do not count on high reading speed at the end of this course.

After completion of the Battelle Course, you will have two choices to make. The first, preferred choice is that you may enter the third stage of the skill-acquisition process by using the reading machine inefficiently for reading mail, identifying currency, checking your typing, reading for fun, etc. Of course, you would also be reading for practice. As you gain skill, you can shift into the fourth stage--the bonus stage of efficient use. Then, with good reading habits and careful planning, your skill will grow further.

Your second choice is to prolong the second stage of the learning process in order to skip the third stage. This may take a year or more of reading largely for practice before you can move into the fourth stage of reading for efficient utility. In other words, if there are no tasks for which you are willing to practice for partial utility at five to fifteen words per minute, then your course will not be complete when you finish the 200 lessons. Most of the students who were lost at the end of this course could read between five and twelve words per minute, but they needed to read between twenty-five and thirty words per minute in order to use the machine as they wished to use it. We have explained earlier the three reasons why motivation to practice sometimes ran out before the fourth stage of learning was reached. On the other hand, our most satisfied and successful users began to use the machine for inefficiently meeting occasional reading needs prior to completing the formal, 200-lesson course.

In conclusion of this section, reading rate (often expressed in words per minute) is but one of three useful criteria of performance. A more basic criterion is legibility, which is most crucial in reading things such as return addresses, checks, bills, etc. The main factors in the development of legibility are aptitude for the code of the machine and practice. Legibility plus practice plus certain other abilities add up to reading rate. Reading rate is crucial in reading correspondence and articles, etc. The third criteria is focus rate: the time it takes to locate, size up, and begin reading a print sample. Focus rate is not nearly as important in reading an article as it is in reading mail. For instance, a student with a high reading rate but a low focus rate would be in trouble reading a page with a complex format or a page on which there are several sizes of print. Although we sound learned when we say that a person with a high focus rate has highly developed ear-hand coordination, we must also sound stupid by admitting that we do not know why some people need more practice than others in developing this skill. Perhaps there are two routes to this important skill--one being a function of focusing practice and the other a function of certain aptitudes.

HOW MANY VISOTONER USERS AND STUDENTS ARE THERE?

The following is a worldwide total, 18 of whom were taught by Lauer:

A. People reading usefully with the Visotoner - 9

B. Students who completed the Battelle Course of training but are making little or no use of the Visotoner - 7

C. Students who had 70 or more lessons of the course - 4

D. Students now in active training - 3

E. One Visotoner student not counted above is deceased.

F. Three students learned the Visotactor, one of whom is still a student and another is deceased.

It is typical of the seven students in Category B, who completed the course of training but are making little or no use of the instrument, that their reading rates at the end of the course were between five and twelve words per minute. They had no use for the instrument at these speeds as explained above. They felt they could not be sure of the results of extended training or the time it would take to reach the higher speeds. Other resources for getting small reading tasks accomplished were often readily available to them. Under these circumstances, these people seem unwilling to invest in further practice. Some of them are still involved in the project, and none has expressed bitterness about his large investment of effort.

There is no place in a research paper for direct expression of sentiment. Ironically, people's feelings, including our own, are what makes this paper hard to write. Our sentiments are indirectly but more fruitfully expressed here as recommendations and actions. When looked at in that way a paper like this has plenty of sentiment.

LIFE-STYLES AND SELF-IMAGES

In most cases, the life-styles and self-images of our students were assets. They viewed themselves as capable, independent investors in their future who placed a premium on their own and other people's time. For two students, however, their life-style or self-image was a serious liability in the training. They did well in the training center environment but had little energy to devote to training when they got home. It will be helpful for future projects to understand that such people need to learn new skills either in a training center or under reduced work loads. An alternative for such people would be psychotherapy in order to raise their efficiency or improve their enjoyment of life generally.

Because of our disabilities and the stereotypes, blind people are very prone to do one of two things. Either we lead lives and take jobs which are very difficult for us in order to "prove" ourselves, or we make life difficult for ourselves through our belief that life must be difficult for blind people. Parents and teachers prophesy "the hard life" for us. Many of us, therefore, do our best to fulfill their prophesy, either by selecting "a hard row to hoe" in order to prove ourselves, or by throwing up emotional barriers of fear, isolation, and inferiority. Congenitally blind people are probably more prone to this kind of weakness, but we have seen it very effectively induced in adventitiously blind people as well.

Candidates for such projects as reading appliances should ordinarily also be people with stable, well-established life-styles. Two of our students who dropped out of the course before completion had not been blind long enough to have formulated their life plans and activities before deciding to learn the Visotoner. Newly blind students in a training center may not be the best candidates for a project like ours although often they do have the most time to devote to it.

AN IMPORTANT EMPIRICAL FINDING

We had thought that a working knowledge of print letter shapes and previous experience in reading with eyesight would be an asset in learning the skill and that lack of such experience would be a liability. We have found, however, that although such experience is an asset, its value is secondary to the acquired hearing skills of persons who have been blind for many years or from birth. In our tentative, empirical judgment, people who have highly developed skill in object perception and, to a lesser degree, those who have well-developed verbal or musical listening skills, have an advantage in learning both the tonal code of the Visotoner and the and the spelled-speech code of the Cognodictor. The most dramatic evidence is that when Lauer demonstrates the Visotoner or spelled-speech and asks for responses from an audience of newly blind veterans at Hines Hospital, the response is often uncomprehending silence. When he demonstrates for a general audience of blind people, many people shout answers and say things that indicate their comprehension of the codes. The 1970 summer project of our colleague, Ann Chapman, shows that many of our best potential candidates for a tonal code are congenitally blind people.

OTHER REASONS FOR BROADENING THE RANGE OF CLIENTELLE SERVED

This training was made much more available to veterans than to non-veterans because of the VA's role in the sponsorship and evaluation and because the VA historically has a very comprehensive rehabilitation system. Of course, we have found excellent candidates among veterans, but there are other reasons why this training should be made available more generally.

1. Women have more of the typing and other office jobs for which reading appliances may be useful.
2. Possibly a higher percentage of non-veterans have no sighted persons living in their immediate households. Such people seem to have more incentive to use currently available reading hardware.
3. During the early stages of reading-machine deployment, when we cannot always predict the amount of need for personal instruction, regional centers--because of proximity to clientelle--could service an area of several states more efficiently than can be done using wide ranging services for smaller groups such as veterans.
4. Perhaps the best reason for making such training as this available for veterans and non-veterans alike is that we could then select the best candidates for learning and using the skill.
5. Experience with the Visotoner Screening Course indicates that there are many potential candidates who want to learn the skill, and, of course, most of them are not veterans.

SUMMARY OF ASSETS AND LIABILITIES

It should now be helpful to the project and the field to summarize the things we feel we had going for us and the things we feel went against the ideal aims of the project.

1. Our greatest assets, for which there is no comparable liability, are the Visotoner accessories designed and built at Mauch Laboratories in Dayton, Ohio.

2. Asset: We offered the training with one partial exception--we did not ask people to take the course. To the best of our ability, we were honest about the potentials and risks.

   Liability: At first we over-estimated the potential reading rates after the training phase (stage two of learning). As a result, some students were left with a skill that did not meet their particular needs.

3. Asset: We had the wholehearted support of the Veterans Administration.

   Liability: Evaluation is complex and expensive, and we should have had more support and cooperation from other sources in order to have served more non-veteran candidates. The reasons were listed above. Plans to accomplish this are under way.

4. Asset: We taught the skill with genuine confidence in its value and the ability of students to learn it. This kind of enthusiasm is essential.

   Liability: We had to be our own advocates and judges. It is hard to mix the roles of an enthusiastic teacher and a cold, calculating, psychometrically oriented evaluator.

5. Asset: We have the use of the Battelle course of training.

   Liability: The Battelle course needs revision now that material for adult beginning readers is available. The Battelle tapes are inapplicable, and we now know that lessons are needed for improving legibility rates, focusing rates and the reading of a wider range of print styles. We have developed some of these lessons.

6. Asset: We had good shakedown procedures and excellent redesign, updating, and repair service, thanks to VA sponsorship and Mauch Laboratories.

   Liability: After all that shakedown work, we now see code and hardware improvements we wish we could try. We now feel that the legibility of the tonal code may be raised by modifying the code. One promising possibility is a binaural code, the preliminary work for which is described in a separate paper. We also now feel there would be much value in a hardware design to permit monitoring of typing and hand writing as it is being produced. For these and other reasons, it seems to be an unavoidable fact of life that our limited resources produce a production model which must incorporate some of yesterday's technology.

7. Asset: The Visotoner Screening Course has been developed and has proven valuable in screening and introducing candidates to the code.

   Liability: The screening course is the first of its kind, and it now needs revision. It had to be validated in use by checking its results against subsequent experience and training of students. The screening course could not, therefore, be fully available as a tool until halfway through the project, so that early students did not benefit from it.

8. Asset: We offer the use of a reading machine to everyone who completes the course and makes practical use of the machine.

   Liability: Our agreement with veterans is unequivocal, but non-veterans are loaned equipment necessarily on a temporary basis. Although they have been allowed to retain the use of it, they had to be made to feel less secure than veterans in their entitlement to equipment. The requirements for non-veterans users were also very stringent--they had to be potential teachers, etc.

9. Asset: We provided training, travel, and living expenses for veterans.

   Liability: We provided training for non-veterans but not travel and living expenses, and they often had to seek their local agency's approval. Some had to pay their own expenses. This is good from a standpoint of individual and agency accountability, and development of teaching resources in the non-veterans sector of the field, but it is hard for evaluation purposes.

10. Asset: We offered intensive individual instruction to beginners. This was vital, and it enabled us to teach people who were not so agile in learning the code as Butow and Lauer. We did prove, as we had hoped we could, that "non-geniuses" can learn the skill if given enthusiastic, individual instruction. We developed telephone teaching capabilities which proved valuable.

    Liability: Most students need another week of individual instruction at the end of the Battelle course at which time advanced instruction can be much more meaningfully presented. However, few students received this training. We did not have staff time to fully use even those telephone and correspondence capabilities that were developed. We doubt that this lack made the difference between success and failure in most cases, however. We are very glad that Mr. Richard Bennett is now employed in the project in California.

CONCLUSION

The following are some common hazards or pitfalls of evaluation projects which we have largely been able to avoid:

1. Although parts of a system can be tested quickly and in laboratories, the evaluation of an entire reading system takes much time and requires realistic conditions. Since reading is a major life skill which takes months or years to acquire fully, evaluation projects should be geared appropriately.

2. A personal reading appliance cannot be tested in a laboratory or library where several people can theoretically use it. We need one reliable appliance for each user and the promise that he can continue to use it after he learns the skill.

There is, however, a necessary limitation to the evaluation of all current reading aids. We must offer to teach the major life skill of reading without much of its intended reward. Our direct-translating reading machines are intended to be offered and used in combination with the optical character reader (OCR) called the Cognodictor and/or time-shared computer services. We also hope to offer a variety of outputs for direct-translating equipment. One of our goals for the near future should be to offer a greater choice of reading aid outputs side by side in the same training centers.

We are assuming here that direct-translating hardware will be augmented by the machines of the future. If such is the case, the future user will still need a long learning process, but he will have the added incentive of greater speed and utility afforded by the advanced equipment. When we can use the Cognodictor or time-shared computer in addition to a direct-translating reading aid, then direct-translating appliances should come into their own. Meanwhile, there are many uses for the present hardware and people willing to pioneer its use. We have the obligation to offer what we can and to learn all we can from the experience.

PERSONAL READING APPLIANCES FOR THE BLIND

Harvey Lauer

During the past four years in which my work has been teaching, testing and demonstrating reading appliances for the U.S. Veterans Administration, the following questions were often put to me:

Which reading tasks can be done with the Visotoner? How does the Visotoner "see the print"? What training facilities exist? Are there reading appliances with tactile outputs? Are any reading appliances ready for the market? What is new in VA reading machine research? These questions form the outline for the present article on reading machine research.

A later article will be entitled "Sensory Aids for the Blind: Are they an automatic bonus or needed tools?" Besides the issue posed in its title, the article will consider the question of what blind people and our friends can do to bring sensory aids through the laboratories, factories, and classrooms, and into our homes and offices.

WHICH READING TASKS CAN BE DONE WITH THE VISOTONER?

In 1964 I began learning to use the Veterans Administration's Battelle optophone[2]. (An optophone is a reading machine which presents the shapes of printed characters to the ear as patterns of tones at several pitches.) Later, I used the first Visotoner, an optophone-style device developed at Mauch Laboratories. At first I could check my own typing. Then reading typed correspondence, bank statements and utility bills became feasible. The list of reading tasks grew along with a greater feeling of independence because the reading machine added to the value of braille, typing and language skills. However, because of the need for technical improvements, enthusiasm for teaching this skill was not generated at that time.

Then in 1967 the Visotoner was redesigned by its manufacturer Mauch Laboratories, Inc., of Dayton, Ohio[5]. The Visotoner was developed under a research contract with the Prosthetic and Sensory Aids Service of the Veterans Administration. The new machine gave greater operating ease and access to a wider range of available print including dictionaries and some kinds of printed instructions.

My first student was Margaret Butow of the Hadley School for the Blind. She uses the instrument to read her worldwide typed correspondence, check her typing and correct errors. Other blind students, most of whom are veterans, came to Hines Hospital for several weeks of training with the Visotoner. We then made use of regular correspondence and telephone instruction to help them complete the course of training at home. Many of them are identifying currency, reading their typed or printed mail and occasional magazine articles. Dictionaries and encyclopedias "come alive" to some of us, and a few advanced students read package directions and ads. Reading handwriting is not feasible for us, but we can check the function of writing instruments and the legibility of our own handwriting. There are now 19 persons using Visotoners. Most of us feel that we have acquired a bit of synthetic eyesight.

Reading speeds for the first year of practice and use have been 15 words per minute or less. After that, higher speeds are possible depending on individual ability and the uses made of the machine; that is, continued use usually increases speed and the number of tasks for which one would prefer to use the appliance. My reading speed with the Visotoner on high-grade typing or printing is 40 words per minute. When detecting the size of print and when reading low-grade or very unusual print styles, I may read several words during the first minute. I find the lower speeds suitable for identification purposes.

HOW DOES THE VISOTONER "SEE THE PRINT"?

The Visotoner contains a vertical column of 9 photocells, an optical system, and the electronic circuits to generate a different audible tone for each photocell while it is "seeing black." The instrument has magnification and lamp controls for adjusting to the size and contrast of print. We cannot say that the machine reads--rather, it presents the letter shapes as tone patterns. As it is moved along a line of print, the 9-tone output is usually heard in an earphone. Each printed symbol has its characteristic tone pattern. When the two lowest tones are heard, it means that the letter extends below the line. Each of the five middle tones responds to its assigned band of print encompassing the middle body or "x" height of the letter. When the two highest tones sound, it means there is print extending above the "x" height. For example, reading a hyphen results in a steady tone. The letter "i" consists largely of a chord, and the letter "v" makes a ripply sound.

The user must learn to interpret these tone patterns as letters and words on the printed page. The long learning process is similar to the experience of a sighted child learning to read ink-print. In teaching this skill, we used a 200-hour training course developed at Battelle Memorial Institute, Columbus, Ohio. The course consists of ordinary printed text to which we have added tape recordings of the Visotoner.

The transistorized Visotoner with its battery and ear phone are carried in a leather case the size of a hard-cover text book. The instrument may be used alone or with its tracking aid which Mauch Laboratories has named the Colineator. A specially designed attaché case holds everything including a spare battery and battery charger.

WHAT TRAINING FACILITIES EXIST?

Miss Margaret Butow, my first Visotoner student, designed and teaches the Hadley Visotoner Screening Course. The course was developed under VA contract with the Hadley School for the Blind, 700 Elm Street, Winnetka, Illinois 60093. This 25-lesson home study course is offered without charge to those who consider themselves potential candidates for learning and/or teaching the skill. The course yields a measure of a candidate's ability to learn the Visotoner code, and it provides a head start in learning that code via tape recordings.

Upon completion of the screening course, several blind veterans and non-veteran potential teachers were trained by me here at the Veterans Administration Hospital, Hines, Illinois. They now use Visotoners in their homes. One of the veterans, Richard Bennett, is now beginning work similar to mine. He will teach and test reading appliances at the Western Blind Rehabilitation Center, Veterans Administration Hospital, Palo Alto, California. Greater availability of the Visotoner will depend on further evaluation, interest, and support.

We feel that a blind person should first avail himself of training given at Rehabilitation Centers or by home services. Then he may consider a machine like the Visotoner as a supplement to basic skills.

ARE THERE READING APPLIANCES WITH TACTILE OUTPUTS?

The Visotactor, built by Mauch Laboratories, is like the Visotoner in every way except that instead of an audible output it uses vibrators felt by four fingers of the right hand. There are currently three blind persons who are reading with Visotactors.

Dr. James C. Bliss and others at Stanford Research Institute, Menlo Park, California, have developed a machine with a tactile output using many vibrators all of which are felt by one finger. There are several users of the Stanford Reading Machine which has been named the Optacon. (Information may be obtained about their encouraging results from the developers of the Optacon[1].)

I wish to emphasize here that we need several outputs of reading appliances in order to match the capacities and meet the needs of blind people. It should then be possible to select the output a person will use according to his ability and preference. For example, users of the Visotoner must possess the ability to distinguish various tone patterns presented, but they do not need all the auditory abilities of musicians. Users of a machine with a tactile output must possess appropriate tactual abilities. Several equipment designs making use of residual vision are being proposed and tested.

ARE ANY READING APPLIANCES READY FOR THE MARKET?

From an engineering standpoint, the Visotoner is ready to be produced in a quantity of 100 or 200 copies, and there is some interest in doing this. There is also interest, both here and abroad, in further evaluation of the usefulness of the machine and the selection of potential candidates.

We understand that a production run of 100 or 200 units would cost about $2,000 each, including accessories. We anticipate that the cost of equipment and training would be borne by agencies and organizations as is now usually the case in other training programs. The blind user would contribute his time and effort which amounts to 200 or more hours of practice. In return for this, he should have the use of a reading machine upon successful completion of the course. The Optacon is at the same stage of development.

WHAT IS NEW IN VA READING MACHINE RESEARCH?

Under its research contract with the Veterans Administration, Mauch Laboratories is developing the Cognodictor[5]. Three prototypes, each the size of a portable typewriter, have been built and are being tested in Dayton and here at Hines VA Hospital. The machine spells words audibly; a braille output could later be devised. Mrs. Bonnie Deal of Dayton, Ohio, is the first blind person to read with the Cognodictor. The machine "identifies" upper- and lower-case letters in many common type fonts, so it should permit more rapid reading at speeds of 80 or more words per minute. A Visotactor or Visotoner is part of the Cognodictor and is needed to locate the print, size it up, and track exactly on the line. Only then will the Cognodictor spell words. The smaller machine must also be used to read numerals and other symbols which the Cognodictor cannot "recognize." This is why skill in the use of one of the smaller machines described earlier will be necessary in order to use the Cognodictor. Of course, the small machine is detachable from the Cognodictor for use in remote locations.

The eventual cost of the Cognodictor will be several thousands of dollars. Its price can be put into proper perspective as one considers other rehabilitation services which also offer life-long returns on similarly large investments.

We need the smaller machines like the Visotoner for their low eventual cost (several hundred dollars, including accessories) and for their high degree of versatility. For example, they can be used to read italicized print, numerals and other symbols and characters used in foreign languages but not found in the English alphabet.

It seems possible that the Cognodictor will be to the Visotactor and Visotoner what the typewriter is to the pen. For example, you would need a machine like the Visotoner to read the figures on your bank statement or to "see" the lines on a printed check or form you fill out. Such tasks are normally accomplished by slow, accurate reading. Then when you turn to a magazine article, the Cognodictor with its electronic logic circuitry and spelled-speech vocabulary would take over and permit higher reading speeds.

As noted, the Cognodictor identifies alphabetic characters in common type styles. The day when a personal reading machine will do much more than this is still far off. Industry's million-dollar computer-assisted reading machines can "read" rapidly and accurately. They should prove useful in improving library services, but they are not as versatile as a skilled Visotoner or Optacon user in coping with the vagaries of print.

In summary to this point, we have discussed two families or levels of reading appliances. Reading machines like the Visotoner, Visotactor, Optacon and others not mentioned here are called direct translating machines because they convert optical information gained from the printed page quite directly into another form in which this information is presented to the user. Such machines use no logic circuitry. They have a minimum of electronic components and require a maximum of user skill.

The second level of reading machines we call Optical Character Readers, because they use computer-like logic circuitry to identify characters. Industry has big, expensive ones, and we hope for the Cognodictor as a personal reading machine. The fact that printed characters are found in so many shapes and qualities means that it is more difficult to develop a low-cost optical character reader than an expensive one. The high research costs of such a project for blind people make it necessary to seek wider support and deeper commitments. At the present level of support, equipment designed and components become obsolete before they can be built and evaluated. This fact is somewhat true of the other reading machines discussed here. However, it has been our experience that the skill in using this equipment does not become obsolete. When better reading machines have been made available to users, the old skills were applicable to the new equipment.

There is a third level of VA-sponsored reading machine research at Haskins Laboratories in Connecticut[3]. Haskins Laboratories is working on high-speed outputs for computer-assisted library services. The output of the Haskins equipment is English sentences. Another future use for the Haskins work is reading by means of a very large, time-shared computer system over the phone. It is hoped that this kind of "over-your-shoulder" reading by a computer may become feasible if and when computer terminals become commonplace in many homes. Such computer services would, for example, operate household appliances, etc. My opinion is that although such computer-assisted reading of materials "on location" may be a long way off, computer-assisted library services rendered by mail or by phone should be near at hand. The first of such services should use computer time only to select, duplicate and mail pre-recorded and pre-brailled texts. The borrower should also be able to stipulate the rate of compression desired. Researchers at MIT and at Stanford Research Institute are also working on various modes of computer-assisted reading.

Those interested in the technical aspects of the VA Sensory Aids Research Program or in availability of training and equipment should write to Dr. Eugene F. Murphy, Chief, Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration, 252 Seventh Avenue, New York, New York 10001.

CONCLUSION

In concluding this article, it should be pointed out that persons who want to use present reading appliances usually have many reading needs of the types listed above and limited resources for meeting these needs. Potential users are also usually among the minority of those who prefer friends to helpers; that is, they value the time of others as much as they value their own. The question now facing us can be stated in three relevant ways.

1. If we improve the capability and availability of appliances, will the minority of potential users grow to include a majority of blind people?
2. Does our need for sensory aids grow as industry puts more and more essential information into print and under the glass covers of meters and dials?

3. To raise the question as it is put in the title of one of my articles: Are sensory aids for the blind an automatic bonus or are they needed tools?

This three-part question can be answered only in dialogue between blind people and our friends. In my opinion, we need this dialogue because many of our friends among whom are legislators, administrators, and philanthropists consider sensory aids bonuses of the affluent society. If blind people feel the need for sensory aids we have not expressed it very well because we think sensory aids are inevitable benefits of the technological utopia for which we think we must patiently wait. If my analysis is correct, then unless those misunderstandings are cleared up, we cannot expect to see much action. I have therefore written a second article in an attempt to spark dialogue between blind people and our friends who are researchers, administrators and taxpayers, and so on.

Technology often makes old ideas feasible. Jet propulsion and magnetic recording were curiosities of the 19th century. Fifty years ago, Mary Jameson of Britain read with the first Optophone at a speed of one word per minute[4]. Today, she is still aiding in the evaluation of the equipment. Her examples of foresight and dedication are still inspiring us.

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SENSORY AIDS FOR THE BLIND: ARE THEY AN AUTOMATIC BONUS OR NEEDED TOOLS?

Harvey Lauer

Does our need for sensory aids grow as technology puts more and more essential information into print and under the glass covers of meters and dials? I can ask this question in my role as a research teacher and tester of reading appliances for the blind. I would like to answer the question as a blind person and as one who uses the Visotoner and other reading appliances discussed in my earlier articles. In writing this article, I must accept the risk of being charged with a "conflict of interests." In other words, I could be called "a researcher plugging further research."

The answer to the question posed in the title of this article cannot, therefore, come from me. The answer must come from blind people in dialogue with our friends among whom are researchers, administrators, tax payers, and so on.

My hope here is to spark dialogue by discussing the following controversial questions asked of me during the past four years in my work. Why do we hear very little about research and development in this field? Are sensory aids a bonus? What can blind persons and our friends do to bring sensory aids through laboratories, factories, and classrooms and into our lives?

This discussion will be continued in a later article entitled "Factors Retarding Sensory Aids Research for the Blind."

We broadly define sensory aids as including braille equipment, mobility and reading appliances, many of the tools and aids developed, tested and sold by the American Foundation for the Blind, the American Printing House for the Blind, Howe Press, Science for the Blind, and others. Sensory aids run the gamut from long canes to electronic hardware. Furthermore, the ideas in most of this article can be applied to the research and development on prosthetic appliances for other disability groups.

WHY DO WE HEAR VERY LITTLE ABOUT RESEARCH AND DEVELOPMENT IN THIS FIELD?

There are many reasons? Most developments occur gradually--breakthroughs often take years to happen. If we continue to seek sensational stories, journalists will continue to write them, and we will never learn what has happened. Typically, a journalist writes a story about a reading machine for the Sunday afternoon reading pleasure of the public. The story is usually accurate when you allow for the fact that the public does not need a reading machine. The public's motives are a mixture of genuine good will, solicitous protection of blind people, and a need for some escape in entertainment. Then the story is reprinted in several braille and recorded periodicals. As a result, blind people receive incomplete and, from our point of view, distorted reports which give rise to false hopes, confusion, and credibility gaps. Of course, the public does not become confused by what it reads because it naturally forgets the details from one story to the next.

The solution is simply to let the public have its second- and third-hand information about research. We should insist that editors of publications for the blind get first-hand information from researchers and sponsors of research. Of course, such information will still not be entirely free from bias, but it will give us a fighting chance of finding out what is going on in sensory aids research for the blind. Care is also needed to print current information. We sometimes find two-year-old articles reprinted and labelled "current research."

What the public does need to be told, and blind people are the only ones who can say it meaningfully, is our opinion as to whether sensory aids are welcomed bonuses or needed tools.

A second reason for lack of information about research in this field is that information is often withheld from publication. Research is hard to explain while it's in progress. Thirty pages of graphs, charts, hopes, and plans boil down to three paragraphs after the work is successfully completed. If the results are negative, even less space may be needed to report it.

Then, too, when a researcher is making good progress, he dislikes taking time to write and put in appearances to explain it. This is also true if his work is adequately supported. Researchers who are not accomplishing much of value or those who need support for valuable projects don't mind traveling and writing. This is why we hear so little about some of the most worthwhile efforts in research. Supporters and researchers should deal with this problem.

There is another problem about which blind people can do something. As researchers, we dislike raising false hopes in the people whom we are trying to help. Our fear, founded in some experience, is that if we try to tell laymen what we are doing they may anticipate a "miracle of technology." Then, when our listeners become hurt and disillusioned, they may not listen to us when we have something important to say.

We can counteract this mistrust by understanding that a technological utopia is not near at hand. Technological benefits are not automatic. It is not "wonderful what science is doing for the blind." Harnessing technology to reduce handicaps takes hard work, bright innovators, and pioneering concern. History reminds us that a uniform braille code was established in the U.S. after a century of controversy at the expense of blind people. Acceptance of new techniques such as mobility instruction and the use of dog guides has taken 25 or 30 years. The struggle for equal rights and opportunities goes on and on.

My opinion is that the positive values of publishing accurate information far outweigh the risks. Our statements about not wishing to raise false hopes are pious only to a degree. We also wish to avoid public pressure, so we complain privately about meager support. This is a mistake. The informed, expressed opinions of blind people would do more to motivate researchers and secure needed support for research than anything researchers could say. All pressure is not unhealthy. If blind people are "under pressure" as a result of changing technology which should be harnessed to reduce our handicaps, let us make this pressure known and felt.

ARE SENSORY AIDS A BONUS?

In my opinion, the prevailing philosophy of administrators, rehabilitation personnel and many blind people is that sensory aids would be a welcome bonus in an affluent society. This philosophy is based on two premises, both of which I call into question. The first premise is that mankind always benefits from modern technology and that no one has been hurt by technical change. It is therefore wrongly implied that any special benefits to groups such as blind people must be classed as bonuses.

The environmentalists among us are not the only ones to call this premise into question. Handicaps exist and must be defined relative to the general population. We seldom consider the possibility that social or technical change can increase the handicaps associated with a given disability. Let me illustrate this with a simple example. Talking books tend to reduce our recreation and study handicaps, but widespread use of "speed reading" instruction for sighted students tends to result in an increase of these same handicaps for us.

In other words, if we are too quick to label change as progress, we can blind ourselves to the effects of change on our handicaps and our potentials. Of course, a highly pessimistic view of change would be equally dangerous to us. A realistic appraisal of the effects of change will show us which sensory aids would be bonuses and which are needed tools.

The second premise is often stated this way, "Surely the country is rich enough so that its disabled citizens need not be asked to work. Sensory aids are no longer necessary because readers and drivers can be hired by government from the ranks of the unemployed." Is this a sign of wealth or of poverty? Has paternalism merely altered its appearance? My answer is an old definition of paternalism: short-range help without long-range concern.

Those responsible for planning rehabilitative services should study the need for technical advancement in services to the blind. Specifically, how are contemporary cultural and technological changes affecting the handicaps of blindness? Are our nineteenth-century tools still adequate or do we imagine them adequate because of paternalistic attitudes? Can we afford technological development? That is, can we justify giving it priorities high enough to get results? Do we view such development as an automatic bonus? Certainly, there is little to show that it is automatic. For example, until several years ago, the VA was almost alone in reading-machine research in this country.

Are sensory aids a bonus? Let us debate the significance of the following statements.

1. Currently, we have largely offset lost ground in industrial employment of blind people with gains in clerical and service employment.

2. We need to take a more long-range view and study whether automation as it affects more fields will increase or decrease the need for sensory aids for blind workers, or whether retraining for other employment would be a better alternative than to develop sensory aids.

3. With the disappearance of the cracker-barrel and the advent of modern packaging, supermarkets and myriad of small appliances, reading is becoming more important in our homes.

4. Sighted persons now learn to read faster because of the "knowledge explosion," and high school and college reading assignments are now larger.

5. I know of no blind traveler who does not view with dismay the progressive disappearance of buses, trains and pedestrians from our streets.

6. Tape recorders have helped us a good deal, but since most of them can be considered "the toys of the affluent society," reliability and convenience are hard to find and costly where they do exist.

7. Typewriters are certainly a major twentieth-century benefit to blind people. Now the outputs of computers and the commercial ardor of advertisers are multiplying the amount of print produced. The fact that machines produce more uniform print than people can write by hand adds to the feasibility of reading appliances for the blind. What an unmixed blessing the typewriter will be when we can read its output, as some of us are beginning to do.

8. Recently, some jobs in the data-processing field have been opened to blind people, but advancement in this field is very difficult for them. Furthermore, as the field grows, changes in technology are creating problems for visually impaired workers which need urgent attention.

9. The availability of low vision aids to visually impaired persons is still lagging far behind technology in many areas of the country.

10. There are worthwhile but meagerly supported efforts to convert the visually readable dials and meters of industry to other kinds of "read outs," so as to open more jobs for blind people.

WHAT CAN BLIND PERSONS AND OUR FRIENDS DO TO BRING SENSORY AIDS INTO BEING?

If we decide that they are needed, what can we do to bring sensory aids through the laboratories, factories, and classrooms and into our homes and offices? We should first inform ourselves of the research and development in progress and get estimates of what can be tried. Then we should study our present and foreseeable needs and study how technology can help us reduce handicaps or prevent their increase. We can then consider the price tag of effort and resources needed and follow our plans with action.

It will be well to keep in mind that a few of us are capable of being pioneers, and that some of us resist change to the bitter end. Most of us, however, are passive, timid, and resistive at first; but we are able to adapt well once the need for adaptation becomes apparent. Let us not wait until needs become painfully apparent.

THE RIGHT CLIMATE IS REQUIRED

It takes courage for administrators and blind persons to say, "Let's go ahead and try this new thing." A rarer element is also necessary which I call the acknowledgement of the right to pioneer. Of course, we should not ask all students learning to use new sensory aids to be pioneers. We should accept for extensive training only those students for whom we have reasonable hopes that they will derive personal benefits from the skills. Our reading and mobility appliances cannot be tested by passing them from hand to hand as was thought several years ago. We should not, however, hide the fact that there is some risk whenever new appliances and skills are involved. We should, therefore, select people who have healthy, positive self-images.

Research and rehabilitation personnel can cooperate so that users of appliances benefit and blind people are afforded the opportunity to pioneer when such is their choice. Our goal should be to match the efforts, benefits, and risks in using a new appliance with the candidate's ability and his wish to pioneer. This is difficult to do, and there are opposite hazards which can greatly hinder research and development. One hazard is that selfish researchers will exploit those whom they pledge to serve. Another is that paternalistic rehabilitation personnel may bar research from their agencies with the result that we are denied the right to pioneer and the possible benefits from the appliances in question cannot occur.

The latter danger has been the major hazard in the past because the pioneering spirit is rarer among us. From infancy or from the onset of disability, we have been the recipients of coddling which is destructive of self-respect. A paternalistic attitude is incompatible with the right to pioneer. This is especially true where the pioneering effort is aimed at reducing handicaps. I therefore predict that if sensory aids become more effective tools, there will be strenuous opposition from patronizing sighted people and from dependent blind people. This is because such people tend to perpetuate forms of training which once met people's needs but have lessened utility in meeting current needs. History's examples are too numerous to mention here. Fortunately, our administrators are not to be found in this category. They acknowledge our right to pioneer.

It is unfortunate that many blind people are so sensitive to paternalism that we block our development and refuse valuable services offered by agencies and friends. Let's remember we have three sets of handicaps. We have a lot to say about the handicaps resulting from the blindness itself. We have more to say about the handicaps imposed upon us by the opinions of others. Perhaps we say least about the third group--the handicaps resulting from our opinions of ourselves. If you were to ask me, "When did you stop feeling like a frustrated failure?" I would have to say this, "It began happening when my friends and I asked me and myself: 'How much of your hatred of pity, your fear of traffic, your secret mistrust of authorities, and your rejection of criticism is due to a rotten opinion of yourself?'" For instance, fear of traffic was conquered with mobility instruction, the instructor's confidence in my ability, and my acquired conviction that I can do valuable work which makes risks worthwhile.

There is a hazardous way to subvert paternalistic attitudes when necessary, and it often works. It calls for the selection of "consumer testers" of a new appliance from groups not ordinarily served by the agency doing the evaluating. The most common example is the involvement of blind staff members of the agency. Employees are less "over-protected" than clients, and the legitimate responsibilities for employees also differ from those of clients. Other alternatives for testing appliances and concepts are sometimes appropriate. One of these is the use of paid "consumer testers."

Please note my avoidance of the terms "experiments" and "subjects." The term "experiment" connotes to the layman either demonstration of a proven fact or the testing of a very risky hypothesis. The word "subject" has come to connote a "guinea pig" relationship. My view is that pioneers are not "guinea pigs," and "guinea pigs" cannot pioneer.

CONCLUSION

If it is true as I have alleged in this article that our friends among legislators, researchers, and administrators feel that sensory aids would be a welcome bonus of an affluent society; and if it is also true that blind people view the development of new appliances largely as an automatic benefit for which to wait patiently; then it is likely that we will see little action in the next few years. So if our decision is that sensory aids are bonuses rather than needed tools then the current costs of two or three tax dollars per blind person in the nation's population is certainly adequate. In that case, we can sit back and compare our meager efforts at developing new sensory aids with the popular utopian expectation of a technological paradise and smile at the comical picture. If, on the other hand, we decide that some sensory aids are needed tools then we can compare our meager efforts at developing sensory aids with the efforts of individuals to acquire and hold jobs. In that case, the picture will take on a tragic aspect.

I foresee three long-range pitfalls or hazards to be avoided in the harnessing of technology for blind people, and they probably apply to other disability groups as well. The first is that we may become embroiled in a controversy like the century-long dispute over a uniform braille code.

The second is that we will delay applications of technology until greater worldwide pressures are felt. By then, unemployment, wars, and famine may so deplete the independent spirits of the world's blind people that changes will be extremely difficult to make. The third pitfall is that scientists, engineers, and sponsors will lose patience with the jealousies, paternalistic attitudes, and other frailties which block progress.

Now, having identified and shared with you my long-range anxieties and hopes, I shall return to work on the tasks of bringing reading machines from the laboratory into use.

I am also planning a third article entitled "Communications Systems for the Blind: Hope for the Foreseeable Future."

FACTORS RETARDING SENSORY AIDS RESEARCH FOR THE BLIND

Harvey Lauer

After several years in my work of teaching and testing the use of reading appliances for the Veterans Administration, I am ready to list a whole group of problems which have nothing to do with hardware design and very little to do with techniques of teaching and using appliances. Perhaps the problems discussed here can be called by-products of our culture and human condition.

The type of problem to which I refer is best illustrated by the lives of pioneering innovators such as Frank Hall, the inventor of the braille writer and braille stereotype machine. Besides having to contend with the worst features of the political patronage system upon which his position depended, Mr. Hall was faced with the controversy over rival written codes. The chief rivals were the proponents of the braille code and the proponents of the New York Point code. After an especially trying series of events, Mr. Hall made a somewhat facetious remark. He said he hoped to complete work on a braille stereotype machine in time to write his epitaph in metal so that the dots could not be rubbed out by the fingers of New York Point readers.

To some extent, this paper is a continuation of a previous article entitled "Sensory Aids for the Blind: Are they an Automatic Bonus or Needed Tools?" That article covered reasons for lack of published information about research, whether sensory aids should be considered bonuses or needed tools, and suggestions as to what can be done about sensory aids.

WHAT ARE THE FACTORS WHICH RETARD RESEARCH AND DEVELOPMENT OF SENSORY AIDS FOR THE BLIND?

While it is true that we could have had machines like the Visotoner (described elsewhere) several years ago, and while we may not have them for years to come, such slow development is typical in fields like ours. There are many good and bad reasons for this in addition to the ones discussed in the earlier article.

1. We failed to examine the real needs of blind people.

Sponsors and researchers used to think that since blind people now have no electronic sensory aids, any appliance would be "better than nothing." From this faulty logic there resulted many inefficient designs which were poorly evaluated and quickly discarded in bitter disappointment. The field produced a score of "research dropouts." What is worse, we often failed to benefit from our experience. That is, our dropouts did not become stepping stones.

2. The job looks easy, but it's not.

Another reason for disappointment is that designing a reading or mobility appliance appears deceptively simple to many newcomers to the field. For instance, several years ago a research sponsor said to me, "You have the Volkswagen of reading machines. We are building the Rolls Royce." My reply was this, "That's wonderful, however, ours is really the motorcycle of reading machines. In case your design falls short of being a Rolls Royce please don't pass up a Chevy on the rebound."

Thinking that a job is very easy can also result in its sponsor giving too little support, then, when hopes grow dim and prophecies of failure are made, support grows half-hearted and the prophecies become self-fulfilling. When the size of the task is under estimated, even initial success can result in final failure. This happens when support is withdrawn after construction of several successful prototypes. For example, the light-sensitive, optical probe has been reinvented many, many times. We have grown more realistic, and the situation has been largely remedied but it is still difficult to get proper evaluation of hardware, and some agencies which sponsor research need to keep better track of work under their contracts.

3. Blind people often lack basic knowledge and realistic goals.

If researchers and sponsors have sometimes incorrectly understood the needs and capacities of blind people, blind people also have failed to communicate our wishes and needs. Let me illustrate this with an extreme example of miscommunication. A hypothetical blind person said, from the depth of his ignorance, to a researcher, "Now that you can put the signals from the printed page into a wire, it should be an easy step to make the machine speak English. Why don't you go ahead and do that?" The hypothetical researcher, from the depth of his ignorance, says, "It looks like you want us to do all the work, so it will be a long time before we can offer a useful tool for blind people." If he is less self-controlled, the researcher may retort, "If you had a reading machine that fit into your pocket and spoke English maybe you'd be too lazy to use it." Then the blind person says, "It looks like you want me to do all the work, I had better regard you with suspicion."

Let me counteract this miscommunication by speaking first to blind people. Basic knowledge of science as taught in good high schools will help us understand and communicate. Secondly, when we fuel our dreams with the spectacular results of military and space technology, we should also awaken ourselves with the reminder that we are the honorable scavengers of that largely military technology. As scavengers, we cannot expect the degree of sophistication used in the "sensory aids" for the guidance and weapons systems of our high-speed military air craft and missiles. I suggest a reevaluation of the implicit philosophy under which we now operate. This philosophy is that we now quietly scavenge the technology of battlefield computers, etc., in the hope that men will not use the fact that we may benefit from their military technology as one of their excuses to perpetuate a world of jungle tensions and warfare.

4. We forget that acceptance of a new tool is a complicated process.

All of us need to remember that there are probably no absolute criteria for acceptance of a sensory aid. A sensory aid will be accepted gradually when its availability, price, training, requirements and convenience match the needs people feel. Now, the needs people feel depend on several factors which researchers may recall from their psychology courses. Our needs vary according to environmental factors, habits, self image, and so on.

An example of an environmental factor is the presence of others using an appliance in question. For example, more and more blind people use canes and obtain tape recorders when they observe others using them and "getting ahead." What this means for us is that our problems are not over after prototypes are successfully tested. It's hard to build demand for appliances which do not exist, but it's risky to build equipment which is not in demand. The demand isn't there without habit and availability, so we are kept busy going 'round in circles like this.

An example of habit formation as a factor here is that teachers and students of skills like braille and the use of reading machines need to plan habit formation in using newly acquired skills. The successful use and increase of the new skill depends on the level of skill, the levels of needs, and the realistic planning and execution of habit transformation.

The third factor, self-image, is negatively illustrated by the fact that a dependent person is one who has been "smother loved" to the point where he cannot trust people as friends. He looks upon others largely as potential helpers. Even in the rare event that he believes himself capable of learning a new skill, he is fearful of the independence and responsibility it may bring. His fear is that it may be too much for him to handle. This fear accounts for his apparent rigidity, and it results in further rejection by others.

Blind people are among the favored objects of "smother love," which can simply be defined as fear and guilt giving rise to domination and pity. Many of us are in no position to accept a new sensory aid until we are reached by accepting compassion. The first users of new skills and appliances will likely be persons with very positive self images. Others among us will then follow gradually.

5. We thought we could test the usefulness of appliances in laboratories.

We learned also from experience that reading and mobility appliances cannot be tested by passing them from hand to hand. As valuable as the laboratory is, it cannot replace life situations for "consumer tests." Sighted persons need to learn about and test the functions of appliances so that skills may be understood and properly taught. However, sighted persons cannot test the usefulness of such appliances any better than they can test the value of low vision aids. A person with normal hearing cannot test the value of a hearing aid; he should test its functioning. When appliances are tested at great length with sighted subjects, it means that either the appliance is malfunctioning or the people are malfunctioning. That is, the people could be over-protective.

6. We have often been short-sighted and afraid of criticism.

We hear complaints that some sensory aids remain in prototype stages for many years. An appliance may be of marginal value or it may take years to make and evaluate needed improvements, especially if the support is meager. Here, however, is an example of the wrong reasons for rejection.

A hypothetical rehabilitation agency refuses to try an early production model or prototype appliance because, "It isn't worth its cost, and if we bring it in, it may start an avalanche of requests we cannot fill. Bad publicity may result."

However, the rehabilitation administrator in a genuine attempt to be fair, calls for an expert opinion from a physician or psychologist. The administrator is unaware that there are independent resources to whom he can turn for information about research activities, and the expert on whom he calls may know as much about the appliance in question as a TV repairman knows about hearing aids. The expert opinion is likely to be, "I advise against it." The administrator concludes that the researcher is probably dishonest. As a result, the appliance--whatever its value or however much its cost could be reduced by demand for its production--is not tested. Thus, ignorance and fear of making small mistakes can cause big mistakes. The fact that an appliance has been a prototype for many years does not mean that it is necessarily worthless.

7. We often tend to be narrow and selfish with our interest and support.

Another factor which tends to retard development in research is that blind people often narrowly support and encourage only those developments which can benefit us individually or as a group. For example, persons with reading vision would not benefit from use of a machine like the Visotoner. Users of the Visotoner would probably not benefit from low vision aids or "closed-circuit" TV systems. It should be remembered, however, that many of these proposed systems are technically closely related. Here are other instances. A blind executive or a factory worker may not need nor care about a machine with which typing can be checked. A typist may not be concerned about efficient library service.

I am trying to show that although our needs vary, our concern should be for one another for two reasons. The first is that the equipment proposed to meet our varied needs is often more closely related technically than we are willing to relate to one another. The second is that if our concern does not spread to one another, to other disability groups, to our communities, and so on to the world, then we cannot look forward to mature relationships and to the reciprocal concern of others for our needs.

8. Modest results and big tasks make support hard to get.

Another reason for slow progress is that our results have been rather modest, and this makes it hard to generate enthusiasm for further support. We have not generally harnessed much of twentieth-century technology to meet our needs. For example, machines like the Visotoner are useful to a rather small percentage of people, however, there are several machines which use many common components and if they become available, cost can be reduced and more people can be served. In the long run, we hope for higher reading rates as our meager knowledge of ways in which machine outputs can be presented to humans is expanded.

9. We fear the obsolescence of our skills.

There is a natural fear among potential blind users that research will make their skills obsolete. This will not be true in the foreseeable future, as I pointed out in an earlier article where I showed that we will need skill with the smaller, direct translating reading machines in order to use the Cognodictor with its higher speed potential. Furthermore, skill in coping with print is highly transferable between appliances with different outputs.

10. Many of us would rather let the other fellow do the work.

Some administrators have a false sense of democracy, they refuse interest and support for research until "all may benefit" or until "more may benefit." This can be a legitimate reason for not supporting research, but it becomes an incredible excuse if these same people oppose improvements in existing systems such as braille teaching techniques and textbooks. They argue erroneously that all may now benefit from our existing systems. So it is that self-interested people who want no change use opposite arguments to achieve their goal. The truth is that we need to evaluate and improve our present systems and develop new ones for the same basic reasons - so that more of us may benefit.

11. Decisions about research are among the hardest decisions to make.

There is a natural fear among all of us, researchers included, that if we accept a system which is less than fully adequate, we may be denied a better one when it becomes feasible. There is a danger of this when mass production is in question or when people are morbidly timid. At present, this fear is premature with regard to reading and mobility appliances because we are not close to mass production. The antidote to this fear is to ask and work for improvements. When I used the first reading machine to read my mail, it was easy to find officials who agreed with us that the machine should be consigned to the rubbish. It was much harder to find persons who felt that the machine should be discarded after we learned from the experience and built better ones. Improvements were made, and now history repeats itself, as we are told that computers will replace all present reading appliances. I hope this statement is true, but I become skeptical when the authors of the statement fall silent or resort to generalities when asked how their computers will aid us in the foreseeable future. I hope this challenge will promote some fruitful dialogue.

My purpose in discussing the negative aspects of the challenging problems in this research is to show that the design of hardware and the evaluation of appliances are far from the only hurdles to be surmounted in sensory aids research. There follows a list of some more of the pitfalls we are learning to avoid:

12. In testing a new appliance, we sometimes fail to ask the right questions.

13. In research projects, as in other facets of life, momentum is a mixed blessing.

14. A teacher's monitor of a mobility or reading aid should be available and is usually essential.

15. Enthusiasm for teaching skill with a given appliance is necessary.

16. Enthusiasm for teaching a skill does not indicate the presence of either objective or subjective attitudes on the part of the teacher toward the appliance in question.

17. When prototypes are being tested, a painfully high degree of honesty is essential in reporting, particularly in reporting damage and malfunctions.

18. After skill with a personal appliance has been taught, the user must be given full access and freedom in using it.

19. Rivalry among the various sponsors and developers can result in healthy competition, cooperation or in angry tensions, hurt feelings and duplication of effort.

20. We have often failed to understand the goals of sponsors and developers in designing sensory aids.

21. We all share a fear that the often fortuitous fiscal breezes which carry us along may die out and leave us by the wayside or become a great fiscal whirlwind and blow us all away.

22. One of our tasks is to learn to accept the necessary risks, say what needs to be said, and do what needs to be done.

In summary, the decision whether to discard, further develop or mass produce ideas and hardware should not be based on fear, ignorance and self interest. That decision should be based on knowledge, concern, and the needs of people. The wisdom to tell the difference between our motives and the technology of dealing with our human frailties may very well make the difference as to whether we deploy sensory aids after half a generation of concerted effort or only after a century of frustration and failure. To state the proposal facetiously, let us now develop a technology of systematic nose bumping against pride, prejudice and paternalism. We should thereby be able to use our pioneering innovators less often as hated misfits and more often as public servants.

THOUGHTS REGARDING THE EVALUATION OF THE KAY BINAURAL SENSOR

Thomas J. Murphy

We are reaching some critical points in the development of a method to evaluate the Binaural Sensor Aid. One point to consider is: what standards are mobility specialists applying in the aid's evaluation? One of the first approaches to be made is: do we teach this auxiliary aid primarily as a clear path indicator or as an environmental sensor? Foulke, in the AFB Research Bulletin No. 23, June 1971, "The Perceptual Basis of Mobility," discusses these two approaches and also raises some interesting questions worth considering as we continue to evaluate the binaural aid. I recommend that evaluators read his paper carefully. Although it is understood that the aid is to be an environmental sensor plus a help in cane travel, in my view the "teacher" himself may not be sufficiently instructed in the use of the aid as an environmental sensor. I am suggesting that four weeks of training of one-to-one instruction may not be sufficient. One-to-one instruction may have been of help, but did the instructor obtain a full understanding of the aid as well as a superior ability to understand and teach its environmental sensing qualities? To the degree he does this, he teaches the aid as a sensor of the environment. To the degree he doesn't then he teaches this as a detector of objects and, mind you, still as an adjunct to the long cane or dog guide method of travel. Also, as evaluation of this aid progresses, the instructor must be in a position to determine how the evaluee is using the aid--as a sensor or detector. If many evaluees use it primarily as an object detector, then this would be due to their training, which is the result of the training the evaluator himself has received. If it takes a considerable period of time for the user of the aid to employ it as an environmental sensor, that amount of time is critical and it has to be within reason (too long a time would seem to decrease motivation and lessen the chances of using the aid as a sensor).

The writer has spent a significant amount of time using the aid and will continue to do so. I tended to use it as an object detector. Obviously, I haven't been trained in the use of the aid; however, because of my own background and present role, I feel "alarmed" at my response. It is important for evaluators to determine how the evaluee is using the aid.

The acidity test, however, comes after six to nine months of "at home" use. Here the client may be on his own, left more or less to his devices and what motivation he possesses. How do we help him help himself, and should we? If our follow-up consists of frequent visits of encouragement, and this seems to motivate the user to keep working with the aid, then one conclusion we come to is: people use the aid when actively encouraged to do so. If no follow-up is used and people use the aid, fine. However, to really determine one of the rules of follow-up, it would appear both methods are needed. If you have more substantial success with the encouraged group, at least you know the cost of constant follow-up has some merit. Whether one can maintain this effort, and afford it too, is another question.

Several years ago I wrote a short article entitled "Motivation for Mobility," The New Outlook for the Blind, 59:5:178-179, May 1965. In that article I contended, and I still do, that a mobility skill without meaningful travel goals is like a man all dressed up with no place to go. Mobility training becomes then an exercise in futility. This leads me to feel that follow-up procedures, as part of the evaluation, should be multifaceted. A mobility instructor making a follow-up visit, asking questions and observing, would uncover "use or lack of use problems." The instructor can solve some of the technical problems of the aid--others he cannot, particularly when employment is the core issue. No place to work, no reason to use the aid--very much? Infrequent use of the aid results in rusty performance and soon, no performance. It would be like the man I once visited after he had completed mobility instruction. "The long cane," he said. "I think it's here somewhere"; as he opened the closet door, and fumbled around, the cane fell out and hit him on the head. "Oh, yeah, here it is, knew it was here somewhere!" The man was unemployed and his exercise consisted mostly of getting up and going to the icebox for another beer. He really had no reason to "go." So, a learned skill had deteriorated to no skill.

Finally, it appears to me that the evaluation of the aid is dual phased: the first part is accomplished at an agency or center under direct supervision and instruction. To learn to use the aid efficiently is the charge. The second part and equally important is: what is necessary to the continued use of the aid? Here there seems to be a need for more seeking of information which will help determine this. It would seem that the team should have as one of its tools a social-researched approach regarding the *need and desire* for continued use of the aid. How to do this is a difficult question. Perhaps a *developed theory of mobility* is the key ingredient. If Foulke's hypothesis is true, then we must know what a blind *traveler needs to know and how it should be told to him*. Eventually this will probably have to be accomplished, if we are not to waste our time. Narrative reports on the use of the aid by evaluees as part of the evaluation technique has some value, but still is a response to an aid based on a travel theory developed primarily by sighted persons. Now may be the time to incorporate the considered opinions of blind persons, including evaluees using this aid, into a theory of mobility different from anything developed to date.

I tend to agree with Foulke regarding present theories of mobility, particularly those which are the bases for the development of electronic aids. Most of them are unsuccessful, to wit, very few persons appear to use such devices regularly. Too, I believe fewer people than we would like tend to use the long cane method of travel, and this after over twenty years of instruction in the use of this method. Are there methods of determining what blind persons want to be taught and how it should be taught to them?

If a more comprehensive mobility theory could be posited, then it might be well to consider, as part of the long-range evaluation of the Binaural Sensor, the establishment of a special teaching center staffed by mobility personnel *thoroughly* trained in the use of the Binaural Sensor. These persons would then instruct over a specified period of time a specific number of blind persons in the use of the aid, hopefully as an environmental sensor. Such instruction might then be predicated on a theory of mobility evolved partly from a new insight into the needs of blind persons as they have expressed it.

Appendix J

GUIDE FOR PARTICIPANTS WHO WILL MAKE PRESENTATIONS IN REFERENCE TO DEVICES

CONFERENCE ON EVALUATION OF SENSORY AIDS FOR THE VISUALLY HANDICAPPED

Washington, D.C. November 11-12, 1971

Each contributor is asked to address himself to the following questions:

1. What specific tasks or services does the inventor claim that his device will perform? Does the device supplement or provide an alternative to existing aids to mobility (e.g., the dog guide and long cane)?

2. What are the characteristics of the population who will find the device useful? Please include age range, intelligence level, degree of disability and a description of the type of environment in which the device should prove to be most useful.

3. What is the present status of the device with respect to evaluation? Please indicate which of the original claims has been examined, the methods used, and a summary of the conclusions.

4. What unanticipated uses for the device have emerged during its evaluation?

5. Which sources of funds were utilized to finance manufacture of the device? If not yet manufactured in quantity, where is it anticipated that funds might be found? What is the anticipated unit cost?

6. What form of deployment network will be needed to provide proper training and service to the individual user of the device? Do organizations now exist which could provide the necessary deployment services?